# HINTS TO PLUMBERS

## ON JOINT WIPING
## PIPE BENDING & LEAD BURNING

SECOND EDITION

PUBLISHED AT THE OFFICES OF THE
DECORATORS' GAZETTE & PLUMBERS & GASFITTERS' REVIEW




Presented by
The Author
March 1896

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ABERDEEN UNIVERSITY PRESS.

# HINTS TO PLUMBERS

## ON JOINT WIPING, PIPE BENDING, AND LEAD BURNING


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*SECOND EDITION, REVISED AND CORRECTED*
*WITH ILLUSTRATIONS*


LONDON

SMITH, GREENWOOD, & CO.

PUBLISHERS OF THE

Decorator's Gazette and Plumber and Gasfitter's Review

19, 21, AND 23 LUDGATE HILL, CITY, E.C.

1896

# PREFACE.

"Hints to Plumbers," as the title implies, does not pretend to be a full and exhaustive treatise on plumbers' work generally, but is rather in the form of a practical text-book on the subjects which are considered to be the most important, and at the same time the most popular, branches of the plumbing trade. The book is, therefore, not intended to supersede the several excellent publications which have been written with the object of covering the whole ground of technical and practical plumbing. As an additional work, however, it is hoped that a more detailed treatment of the particular subjects, and especially that of joint-making, may be of some value to all classes of plumbers.

On looking over the series of articles which have appeared in the columns of the *Decorator's Gazette and Plumber and Gasfitter's Review* under the above title, and considering the numerous inquiries which have been received with regard to their publication in book form, the proprietors of that journal came to the conclusion that the subject of the articles would be especially suitable to students joining the practical plumbing classes which are being formed all over the country. And, as the whole of the matter is the outcome of considerable personal experience in the

trade, there are probably many "Hints" which may be useful to others who have arrived at a stage higher than the position of students or apprentices. That some of the remarks will be questioned and some of the methods disagreed with, one has no doubt, but this is one of the peculiarities of the plumbing trade, perhaps in a larger degree than in most of the other crafts. This is more especially the case during recent years, because there is no trade which has made more rapid progress in the last decade than plumbing. And, what is more, the improvement has proceeded from within, for it has been the practical men who have given impetus to the progressive movement. And although there have been prominent leaders, all those of average experience have had their share in perfecting the improved methods of sanitation, notwithstanding the difference of opinion and conflicting ideas which have been so prevalent.

It is therefore hoped that difference of opinion will not in any way lessen the interest and instruction which "Hints to Plumbers" may afford to my fellow-workers in the plumbing trade.

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# HINTS TO PLUMBERS.

## INTRODUCTION.

THE ancient craft of plumbing has never been brought more prominently before the eyes of the world than it is to-day. Until the last few years the plumber has been looked upon more as a necessary evil than a man in whose hands are placed to a very large extent the means of checking or spreading those epidemic diseases which have been such a scourge to the inhabitants of large towns.

Eminent scientific men have proved to us beyond a doubt that so prolific are the living germs of zymotic disease that under the old style of plumbing and sanitary construction the dreaded enemy is "laid on" to the houses of rich and poor as completely as if it were a necessity like water or gas. If this is true, how many thousands of houses in London and other great populous places are in this condition—not excepting even the mansions of the wealthy lord, a man who will give a thousand pounds for a ring for the finger but will hesitate and bargain and get the very lowest tender for having his house fitted up with those necessary appliances which provide for the health, comfort and convenience of him and his household: when he discovers, too late, in a few years, or even months, that the water-closets are out of order, the bath cocks leak, and, there being no safe under the bath, the water has spoiled a

valuable ceiling. The waste also is probably connected with a large D-trap under the closet, and when the closet is used, there being only a $\frac{3}{4}$ service to it, the foul matter in the D-trap is only stirred up, and sends a foul smell up the bath waste into the room.

The lavatory waste, too, after being dipped down about two inches to form a trap, is taken into the soil pipe, which from the effects of discharges from other fittings of its own, is generally to be found with the water syphoned out and forming a ventilating pipe from the soil pipe to the nearest room, especially if there is a fire, and the room not properly ventilated. These and many other defects (that we shall have to consider subsequently) are found out very soon after the house is occupied.

Now, the question has been asked, who is responsible for all these seriously faulty arrangements? Many have said the plumber, others have said the builder, some the architect, but very few have said that the man who has to pay for it is to blame. I think false economy has a great deal to do with it, for it is generally accepted that if you pay a good price you can obtain a good article; and the fact is, that the importance of good plumbing has been so little appreciated that it has been treated as a matter only to be tolerated as a bare necessity. The consequence is that until the last few years plumbers have had little or no encouragement to improve themselves in the art and craft of their trade.

Another significant thing to notice is, that architects have taken the trouble to draw out the plan, sections, and details for nearly every other branch of building, constructions, and fittings; but have scarcely ever thought it necessary to give the plumber a single line in the shape of drawings as to how he is to carry out his work.

But things are looking brighter for the plumber now.

He is being lectured by eminent sanitarians and scientific men, who tell him that he forms an important part of the workers after all, and the more he educates himself in the technical as well as the practical part of his trade, the better it will be, not for him only, but for the whole of the community. Let us then open wider the way for the educating influences of our time; because I think the best way to improve ourselves and our trade is to destroy that nonsensical exclusiveness that has been so much a characteristic in members of the craft.

Let us encourage all the means which will enable us to exchange our views and experiences, and so mutually instruct one another in practical as well as theoretical plumbing.

With these sentiments in view I intend in the following chapters to set forth as clearly and plainly as possible my knowledge and ideas of the most important parts at least of modern plumbing. Many experienced men will no doubt think some of them simple and commonplace, but to those who read them, and have these thoughts, I would most respectfully suggest that they will pass them on to those (and there are many) who have not had the opportunities to see good work; perhaps have served seven years' apprenticeship with the object of learning the trade, but have been kept nearly all that time to painting and glazing. These men, if they should come to London for a job, will find that they have another apprenticeship to serve before they can work beside a plumber who has learned his trade at one of the leading shops, especially where plumbing is made a speciality.

# CHAPTER I.

## PIPE BENDING.

BEFORE proceeding with the practical subject of pipe bending, let us consider the reason why plumbing, both as an art and a science, has made such rapid strides to the front within the last few years. Some would have us believe that it is a lost art, and refer us back to the good old times, as they are called, before the new-fangled sanitary ideas came into vogue. I suppose they mean the time when anything in the shape of a box with a lip in it passed for a trap, or when a great bulbous patch of solder round the two ends of a pipe answered for a joint, or if it was awkward to get at, one end slipped into the other, and a piece of red lead stoppedround it was thought quite near enough for the purpose. Certainly some plumbers in those days could make a sound joint by overcasting it; but this was the exception, not the rule. But we must not go back very far with our investigations, or we shall probably lose sight of the plumber altogether.

We read that in the middle ages plumbers had to cover roofs and other surfaces on churches, etc., and supply and lay down small conduit pipes for the supply of water to houses. But we look in vain for any account of work that can approach the lead-work that has been executed by the plumbers of recent years. In these days of sanitary reform, we are required to boss our sheet lead into all manner of artistic shapes and forms without distressing it to any appreciable extent, to wipe our joints symmetrically and perfectly, and to bend our pipes in such a manner that they should not only fit the place they are made for, but be equal

both in bore and substance; for "sound" work *only* is not necessarily good work in this age of progress. Plumbing, then, considered as an art or a science, or both, as we understand it, is quite modern. The reasons for this state of things are not far to seek. The comfort and convenience of water-closets, baths, and lavatories were not thought of until the latter part of the last century, especially water-closets, for nothing is known of one suitable for fixing above the ground floor until the year 1775; of course, we are now referring to our own country. On looking to history, however, we find the ancient Romans had baths fitted up very luxuriously, and had them supplied with hot and cold water; but we can gather no information from this source that is instructive to the trade. Another very good reason is that the principal material the plumber uses was not manufactured in the way it is now. He had to use it in such a rough state that it was impossible to do the work in those days that is required now. Especially was this so with regard to lead pipes, which in the case of soil pipes, until the last few years, were made of cast sheet lead of very unequal substance, and the seams soldered. Some, such as water mains and small service pipes, were cast in short lengths in sand moulds. Many of this kind have been found in the ruins of ancient Rome, where they were used as conduits for the conveyance of water to baths and fountains.

The first assistance given to the lead-worker by machinery was its application to the manufacture of sheet lead. Then, probably for the first time, were produced sheets of equal thickness throughout. This advance in the preparation of the raw material enabled the plumber to make up his pipes and traps with much greater neatness and strength; there was not so much danger from leaks on account of sand holes in the lead; the even thickness made it possible to boss it over intricately carved surfaces, to boss

up breaks and corners instead of cutting and soldering and turning dog's-ears. I do not mean to say this was quite impossible with all cast lead, but every plumber that has had anything to do with cast lead knows that it is a very risky job.

The next improvement was in the manufacture of lead pipes without seam. This new kind of pipe did certainly do away with a lot of work in the plumbing trade, but what was lost in one way it made up by the extra lengths of pipe required to make the work perfect from a sanitary point of view. Although the patent pipe has been used in London for nearly twenty years, it has not been taken to very much by provincial towns, especially in the north of England, until the last few years. They did not seem to like giving up the style of making their pipe and soldering the seam with the copper bit, and making bends in two pieces and soldering both sides. But since sanitary engineers have condemned the soldered seam, the patent pipe has gradually made its way into practically all the principal towns. Now one of the great difficulties with many plumbers is how to bend it, and as this is one of the first jobs that has to be done in a new house I thought it would be the best subject with which to start our hints on practical plumbing. Although patent pipe has been in use so many years, there are comparatively few plumbers who make a bend as it should be made. Some "bends," if we can give them the name, look as if they had been drawn across the knee, and then dropped on the floor on each side. They fixed them, too, in such a way as to lead one to think that the first discharge from a closet would stop them up. Rather than do this, they had better be cut and soldered to form elbows, although this process is greatly to be condemned, especially if it is not carried out with great care. There are many objections to this way of bending pipe, but one of the most common faults is to get one edge standing up sometimes an

inch above the other inside the elbow, and so forming an obstruction to the soil as it passes down the pipe, a complete stoppage being the ultimate result. Of course this contrivance can be made to answer the purpose if care is taken to work the top edge down over the lower one. If the elbow, however, is made in the middle of a length, it is difficult to do this. But after all, it is at the best a bad job, and never looks worthy of a good workman.

There are many ways of bending patent pipe. Years ago some plumbers used to have an iron ball, like a round shot, made to fit the pipe, then after dressing the latter on each side, and bending it roughly at the place required, the end of the pipe was held up nearly vertical, and the ball dropped into it, the pipe was then turned the other way up, to enable the ball to roll out again. This was continued until the ball forced its way through the bore of the pipe at the bend, but it had the effect of making the back of the bend so thin that sometimes the iron ball would force its way through, and, consequently, spoil the entire length of pipe. Even if the ball did not come through it generally made the bend so thin that it was not fit to leave for a good job.

Another plan was to fill the pipe with sand, and plug or solder up the ends. Then, resting the ends on the edge of the bench or stool, a weight was brought to bear on the part where the bend was wanted, the sand inside preventing the pipe from collapsing. It was impossible, however, by this method to make a sharp bend without distressing the back to a very large extent, and often causing it to break right across. But these styles of bending pipe will not compare with the modern way with the use of dummies, by which means we can get an equal substance all round. For this is the test of a well-made bend, that to whatever radius or angle the bend is made, it should, when finished, be of equal thickness in every part.

## CHAPTER II.

### PIPE BENDING (*Continued*).

THE operation of soil pipe bending is essentially what is technically termed bossing or so working the material that a superabundance of substance in one part is moved to another, where by the action of bending it is distressed or made thinner; this should be one of the principal studies of the plumber, the very fact of a man not learning the nature of the metal he is using causes so many failures in this particular branch of the trade. Consequently it is not enough (in these days of progress, when technical education is spreading rapidly in all trades) that a mechanic should know *how* to do this work only, but should be able to give a reason *why* he does it this way or the other.

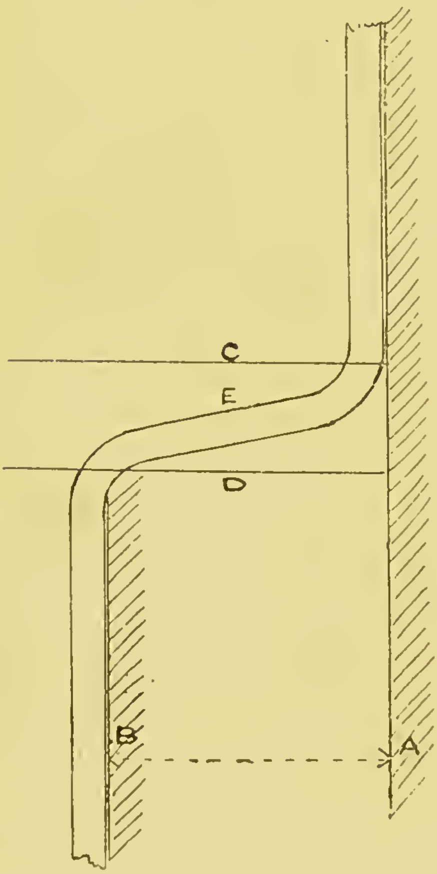

FIG. 1.

The first important thing wanted to make a bend is a good solid bench, and three or four dummies bent at the

head to different angles to suit the bend to be made, whether it be a sharp or an easy one. The best way to make dummies is to cast a lead or solder head about the size and shape of an egg, on the end of a piece of $\frac{3}{8}$ in. or $\frac{1}{2}$ in. iron barrel, after tinning the end; this is much better than solid iron rod, because the barrel is much lighter and not so flexible in proportion to the weight. For very short bends a Malacca cane with a solder head is very useful; these are made by fitting a piece of $\frac{1}{2}$ in. or $\frac{3}{4}$ in. lead pipe, about 2 in. long, on the end of the cane, and driving a few copper nails through it, then, after tinning the heads of the nails, and shaving the pipe, a head can be wiped on just the same way as wiping a joint.

The next important thing is to get the correct dimensions of the single bend or set-off, and set it out on the floor or other level surface. This will save a large amount of time and trouble. I have seen much time and labour wasted by the neglect of this plan by otherwise good workmen, who, having taken only a rough measurement with the rule, have had to take the bend from the bench to its position to fit it seven or eight times, and very often up several flights of stairs, whereas if they had taken a little trouble at the first to strike a few lines with the chalk-line, they would be able to finish the bend before it leaves the shop. Some plumbers use a piece of 1 in. or $\frac{3}{4}$ in. lead pipe, and make a template of it. This is a very good plan, but it is not so reliable as a sketch made to proper measurements.

After having struck the straight lines, there is no necessity to use the compasses for striking the bends; these can be drawn freehand; but in all cases let them be as easy and with as large a radius as possible. It is a great mistake to make sharp bends where they are not necessary, as they are not only more difficult to make, but take more time,

and do not look so well as those made to an easy curve. For instance, suppose there are two bends required to set-off from the angle of a wall, and to pass under the floor to another angle below, as in Fig. 1, take the width between the vertical lines of the angles, and strike them parallel to each other, as shown at A and B; then mark the depth between the floor and ceiling, and strike the lines C and D; now strike the lines representing the soil pipe parallel to the walls, and continue them under the floor, allowing as much fall as possible after giving sufficient space for easy bends. If it is convenient to have a joint under the floor at E, the ends could be fitted, prepared, and tinned ready to be fixed in its position.

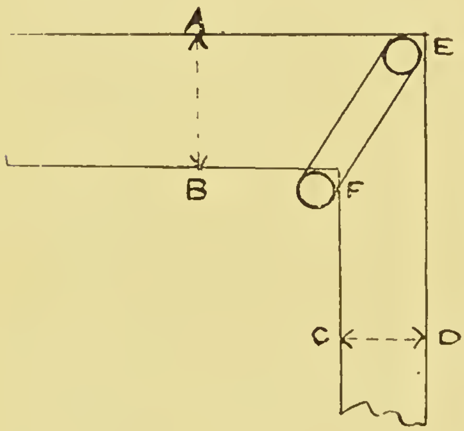


FIG 2.

If the angles or walls are not opposite to each other, then a plan should be made first, as Fig. 2, so as to get the width between the vertical lines more correctly. Take the widths between A and B and C and D; strike the lines to the angles; then after drawing the plan of the pipe in the angles, a correct dimension can be taken to give E and F the width between A and B, Fig. 1.

If two or more bends are required in one length of pipe, the one nearest the middle of the length should be made first; as this will be the most difficult to make, it will be necessary to use the dummies from both ends. Lay the pipe on the lines, and where the bend is required strike a blow with the round dresser, always allowing 3 in. or 4 in. longer than the net length, because it will be found that

while the bend is being made nearly that length will be contracted into it, the cause of which is easily explained. Imagine that the pipe is cut nearly through at the spot where it is to be bent, and the two pieces brought to an angle of 80 degrees, a gusset piece would be required to fill the space where it is cut. In the process of bending the pipe an equivalent of this gusset piece has to be worked into

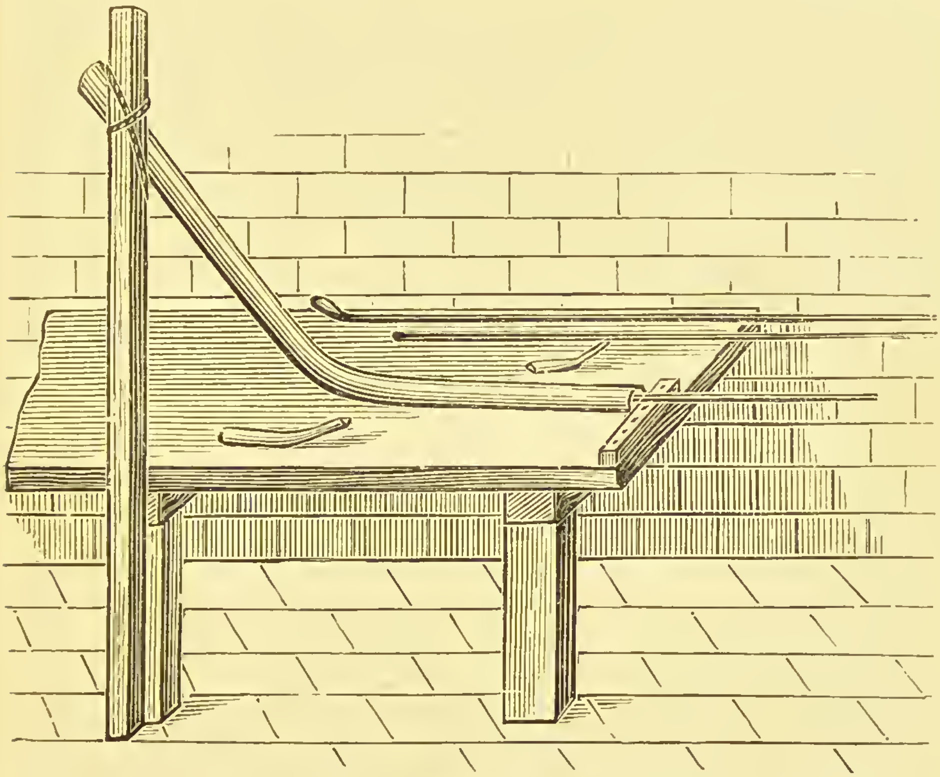

FIG. 3.

the bend to make it equal in substance to the other part of the pipe.

The pipe should now be placed on the bench with the end farthest from the bend raised up about a foot off the bench by means of a rope attached to a rafter or joist, as shown at Fig. 3. If this cannot be done a piece of timber should be nailed to the leg of the bench, standing 6 or 8

feet above it. From the top of this the end of the pipe can be suspended.

Heat that part of the pipe where the bend is to be made to a temperature sufficient to evaporate water quickly when sprinkled upon it. The warming can be done by putting lighted shavings inside or by pouring molten lead on the outside. Solder should not be used for this purpose if it can be avoided, as it not only causes it to deteriorate by constant heating but wastes it also.

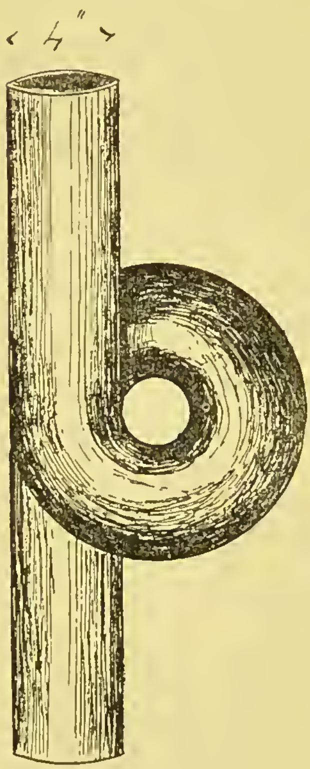


Fig. 4 A.

The best plan is to apply heat inside by the aid of a piece of $\frac{1}{4}$ in. iron barrel connected to a gas burner with a few feet of flexible tube, or by means of a gas blow-pipe, many of which are being used by plumbers for all purposes. See Fig. 138. By this means the flame can be easily regulated to give the heat required; it also saves time and is much safer than lighted shavings in a building.

I have known plumbers who do not like heating the pipe for bending, because they say it ultimately causes it to become harder. My own opinion is it rather tends to permanently soften it. Lead being compressible to a certain extent, it is only reasonable to suppose that the pressure brought to bear upon it when it is manufactured causes it to become harder than when it is cast, when it is afterwards heated it expands, and being free from any pressure it would naturally remain in much the same state as when it was cast, and every plumber knows that cast lead is much softer than that which has been through the milling process.

When the pipe is at the right heat, press on the part to be bent with large felt until the back of the bend nearly touches the bench; then with a round-faced dresser drive, by a few sharp blows, the two sides that are forced out by the pipe being partly collapsed round to the back of the bend, at the same time allowing the back part of the bend to buckle inwards; this will not only prevent the back stroke of the dummy injuring the back of the bend, but will rather tend to further thicken it. This is indeed the most

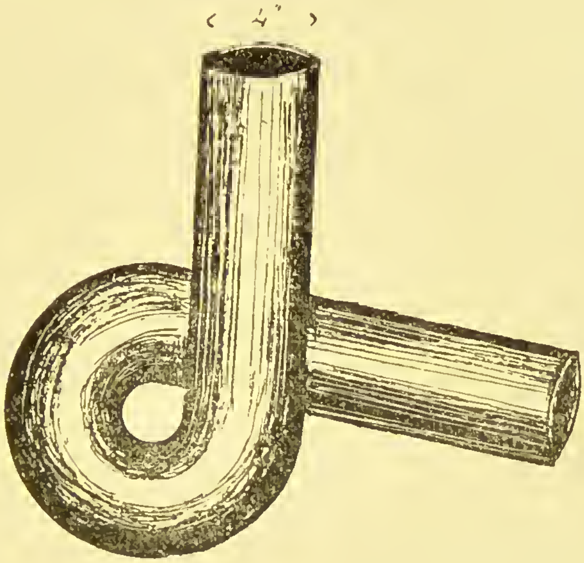

FIG. 4 B.

important thing to be kept in mind, for if the back is not well thickened by the surplus metal from the sides, every time the bend is made sharper, the probability is, it will break across the back before it is half finished.

Now let the labourer (or "mate" as he is called in London) proceed to knock out the collapsed part of the pipe with the long dummies, using them as levers with the end of the bench as a fulcrum, while the plumber beats out the irregularities, and produces a regular thickness all round with the round-faced dresser.

This process should be continued until the bend is the proper angle ; it is very unwise to bend or pull up too much at once, this causes bad buckles to form in the throat which very often crack and spoil the bend. It can be made much quicker by pulling up a little each time than by trying to do too much at once. Care should be taken not so much to get the back thick as to get an equal substance in the throat of the bend ; some think it impossible to get the throat too thin, but this is a mistake ; it is just as easy to go to one extreme as the other. I have seen bends that were so thin in the throat that they would scarcely bear the stroke of a dresser. Especially is this the case when they are bent very sharp ; of course sharp bends can be made as regular as easy ones, but they should be avoided as much as possible.

Some very fine specimens of pipe bending were to be seen at the late Health Exhibition. Fig. 4 A and B are sketches of two among many others that are called knot traps ; they are made of 4 in. 7 lb. pipe and give a very good idea of what can be done with patent drawn pipe, but they are very rarely brought into practical use. Fig. 7 A and B are two more sketches of some traps, these were exhibited on the journeymen plumbers' stall at the Medical and Sanitary Exhibition held at Kensington in 1881 ; they were bent out of 3½ in. 7 lb. pipe. There were two like Fig. 7 A, and one like Fig. 7 B, the owners of which received each a certificate for special excellence of workmanship.

Although there is nothing extraordinary about these traps, they at any rate show the kind of bending that can be done with dummies, whereas by the other processes referred to they would be practically impossible.

# CHAPTER III.

## PIPE BENDING (*Continued*).

THERE is probably no other branch of the building trades in which there is more ingenuity and inventiveness brought into play than in internal plumbing.

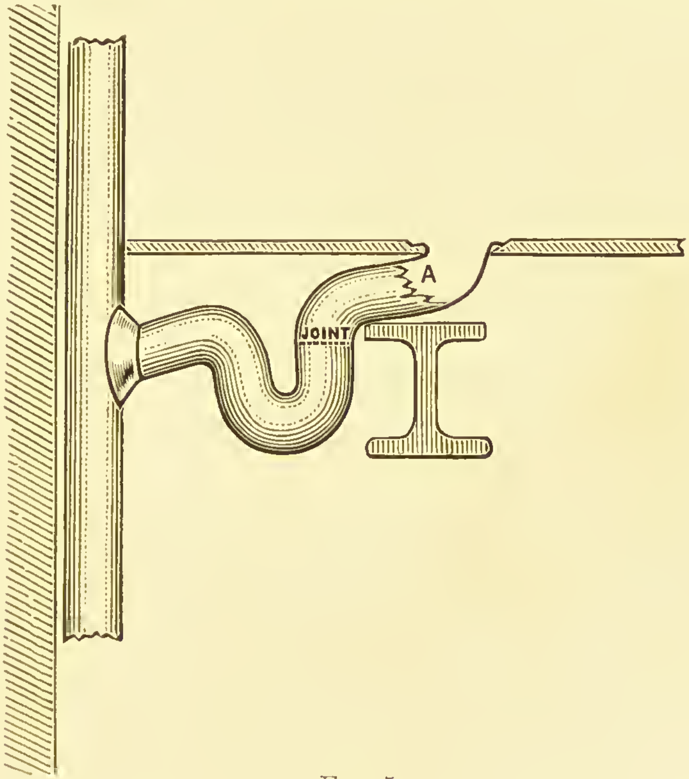


FIG. 5.

Especially is this the case in large hotels and hospitals. Every part of the building seems to have been arranged and planned to the greatest exactness so far as the structure is concerned, but very little thought is exercised in the matter of plumbing. This is quite an afterthought; the

consequence is the plumber is often puzzled what to do to fix his work so that it shall be both sound and efficient, and very often causing a large amount of loss of time and temper, which could have been saved if he had been consulted in the first instance. As a case in point out of many that one meets with, a complaint was made of a closet, that every time the handle was pulled up a very strong draught accompanied by a stink from the soil pipe came through, causing much inconvenience and danger. The apparatus being a pan closet made it all the more serious. The pan would sometimes have the water syphoned out of it by its own discharge, or if a hole was bored in the top, as is very often the case, the stink would escape there. It was evident there was either no trap under the apparatus, or, if there was, it was of very faulty construction. However, on taking up the closet and floor it was found that there was an iron girder immediately under the centre of the closet, the top of which was about four inches from the floor. It being rather a narrow opening, there was no room to fix the closet on one side of the girder, so that to get it in the centre a very shallow trap was made of a very faulty description, having not more than 1 inch dip, and on account of the soil pipe not being firmly fixed, it had slipped down, and drawing the outlet of the trap with it had destroyed the water seal, hence the strong draught through the apparatus.

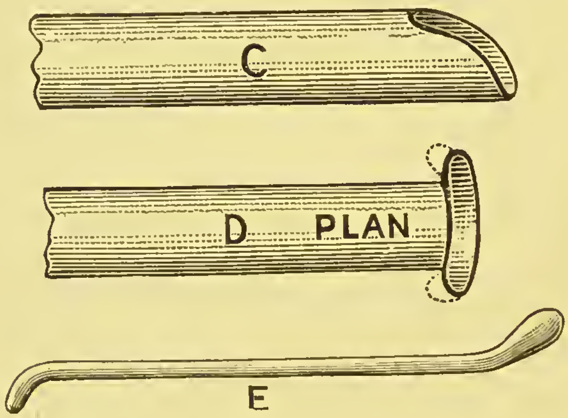

Fig. 6.

Now, as this same apparatus and seat had to be fixed again, it was necessary to fix a proper trap to prevent any smell passing through.

Although it is not pretended that there is anything very particular about this job, yet it serves to illustrate another part of our subject of pipe bending. In the previous chapter I insisted very strongly upon the advantages of easy bends, but as we have to be ruled by circumstances it was necessary in the above case to make two very sharp bends (Fig. 5). They are generally termed knuckle bends, and will be found very useful in many cases where branches from fittings run under floors, and have no room for a good fall, consequently have to be kept close up to the floor at the highest end as at A. It will be seen that it is not necessary for the upper end to be longer than 2 inches from the throat of the bend. But if it was bent the same way as an easy one, several inches longer would be required, so that a mandril could be placed in the end to pull it up by, but this process is not necessary with these short knuckle bends. The best way is to take a piece of pipe about 6 inches longer than the throat of the bend, and cut the end as shown in Fig. 6. Warm it as before described, and knock the back of it up with a flat dresser, until it is like D, then knock the two projecting sides round, as shown by the dotted lines, this

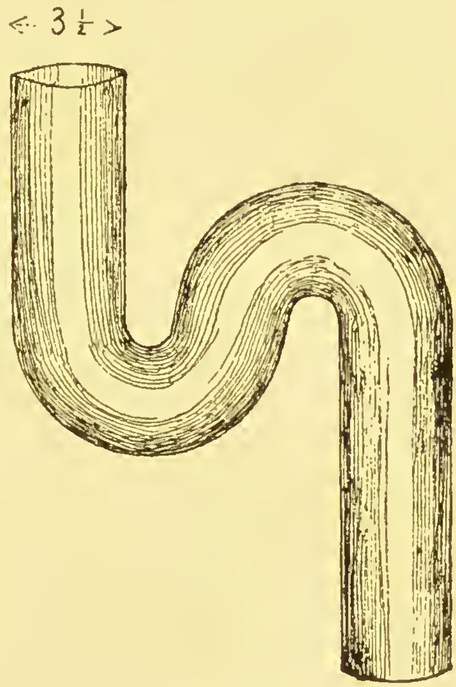

FIG. 7 A.

process is just the reverse to that adopted in making a bend farther from the end of the pipe, because instead of driving the lead round to the back, by this plan it is driven to the throat. Now, instead of using a dummy, take a large bolt, which consists of a piece of ¾ round iron or steel about two feet long, with a bend at each end, one sharp and the other easy. A great improvement is to have one end made round like the head of a dummy E, this prevents the end of the bolt injuring the pipe. Place the bolt in the pipe at the corners shown by the dotted lines, and by the aid of a large hammer knock the inside edge in towards the throat, keep the pipe well heated, and repeat the process three or four times. After the bend has been brought to the shape required with the hammer and bolt, finish it with a short dummy and boxwood round dresser, but of course using a flat dresser for the back. There is no difficulty in getting the back thick in these bends; there is more probability of making the edge near the throat thin; but this can easily be avoided if care is taken to work the sides well into the throat, and draw the back edge up with a small mallet and dummy. With a little practice this kind of bend can be made very quickly, and will be found very useful in many instances. A knuckle bend of this description can be made in about three-quarters of an hour, whereas if one is made farther from the end with dummies,

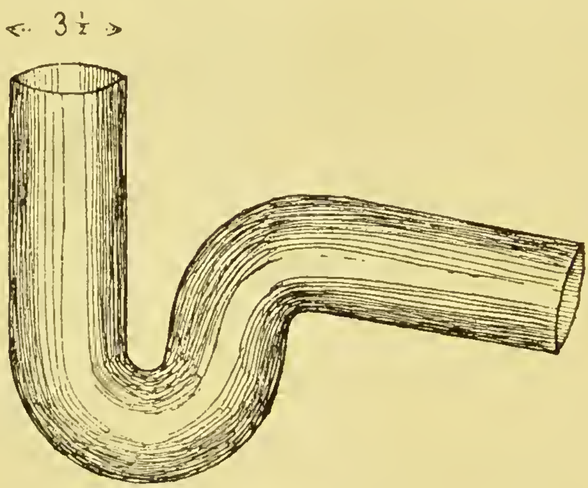


Fig. 7 b.

it often takes two or three hours. Bends in pipes down to the size of 3 inch can be made easily with dummies, although sometimes they are used for $2\frac{1}{2}$ inch pipe, but it is a very difficult job. Many plumbers use for small pipes what are called bobbins (some call them cores) and followers. The bobbins consist of pieces of boxwood about the shape of an egg, turned to fit the different size pipes, from 4 inch down to 1 inch. The followers are short pieces of any kind

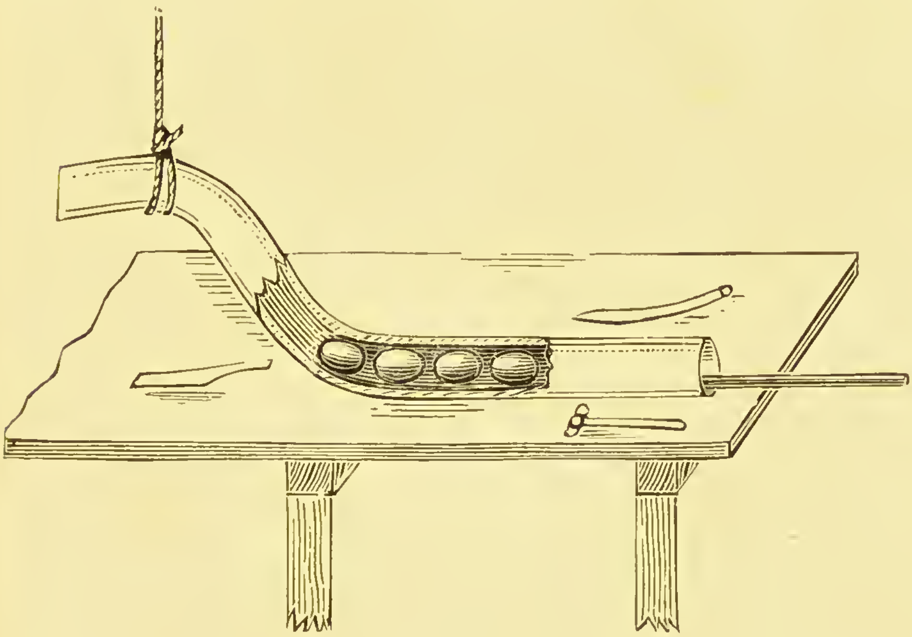

FIG. 8.

of wood, a little smaller than the bobbin, with the edges trimmed off. They are used in the following manner: Where the bend is required the pipe is dressed each side, to flatten it to about half its diameter. It is then heated with molten lead, or some other means, such as lighted gas or shavings; then pulled up a little at a time. After each time it is pulled up the bobbin is placed in the pipe and driven through by aid of the followers. When there

are enough followers to send the bobbin from the bend to the other end of the length, they are forced through with a piece of timber, the end of which is hit with a hammer, as shown at Fig. 8. This process is repeated until the bend is brought to the required angle.

Although I have briefly described the use of bobbins because it might be interesting to many, yet their general use is greatly to be condemned. The mischief they have been the cause of is beyond all reason. They nearly always make the back thin, and very often the bobbin, or one of the followers, is forced right through the back of the bend, besides causing no end of time and trouble if one of the followers gets twisted across the pipe. Cases have been known where the pipe has had to be cut to get them out. I have heard of cases where they have been left in until the pipe has been fixed, a piece of pipe having to be cut out to get the followers out. My opinion is that if bobbins are used at all they should *not* be employed for making the bend. But make the bend in the ordinary way by carefully warming it, and dressing it on each side, so that the cross section of the pipe is the shape of an egg with the small end at the inside of the bend; now pull it up gently and easily, so that no buckles are formed. Do not pull up too much at one time. Then dress the bulged sides round to the back, by this means keeping an equal substance at the heel of the bend. It is very seldom that a bend is required sharper than can be made by this means. Now when the bend is made to the proper angle, it will not do much harm to well warm the pipe, and drive the bobbin through to finish it. If this plan is carried out it will be found that the bend is made quicker and better in every respect, and in most cases the bobbins will not be required at all.

A well-known author has stated that "a plumber who cannot bend pipe without bobbins should *bob* out of the

trade altogether". This may be rather an extreme view of the matter, yet I think the use of bobbins should be classed among the many innovations that have been introduced into the trade which have been the means of bringing much discredit upon the plumber and his craft. If anything can be invented that will enable us to make our work better,

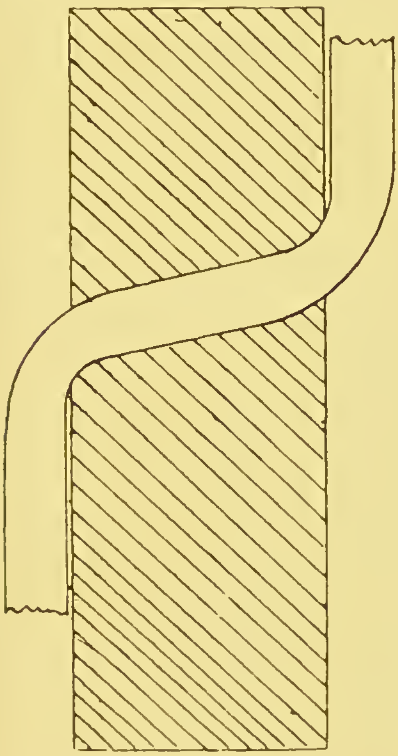

Fig. 9.

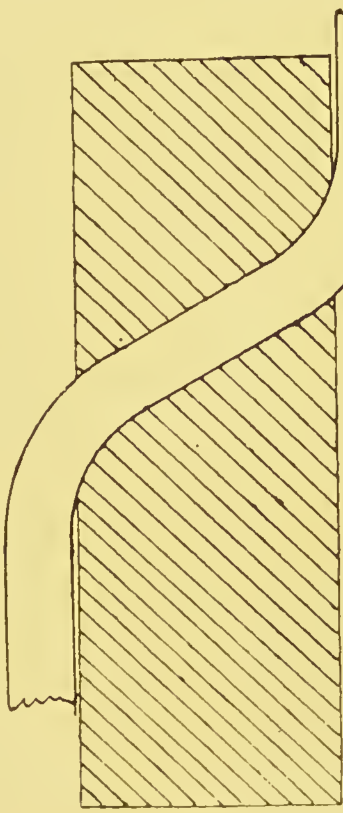

Fig. 10.

stronger, and more artistic, by all means let us welcome it; but when it encourages unskilful workmanship, and at the same time renders the material we use (and from which we take our title) less suitable for the purpose it is intended to serve, it is time then for the plumber who takes pride in his work to throw aside all makeshifts and do his work in the most skilful manner possible, and thus keep out of the

trade so many men who have not the least right to the name of a lead-worker, but should more correctly be called lead-spoilers. During my experience of more than twenty years of London plumbing, I have never once found it necessary to make a bend with a bobbin, and never used one for that purpose, and can say the same of scores of other men whose skilfulness as plumbers cannot be questioned. Generally the smaller size pipes are used heavier and thicker than larger ones, which makes them less likely to buckle while being bent, although the lighter pipes can be bent without any difficulty if the bends are made easy. For instance, what necessity is there for making bends on a pipe that has to pass through a wall so sharp as Fig. 9, when by cutting the edges off the brickwork they can be made easy, as Fig. 10, at the same time looking much better and causing less obstruction to the waste water passing down the pipe? This may appear very simple to some, but it is none the less a fact that some plumbers seem to try all they can to make the bends as sharp as they possibly can. Especially is this the case when bobbins are being used, when their own sense ought to tell them that this is the very worst kind of bend to use bobbins in, because the sharper the bend the greater resistance there is to anything being driven through, and the part that offers the most resistance is the back of the bend. It necessarily follows that the back is distressed to a very large extent, and very often makes a 10 lb. pipe as thin as 5 or 6 lb. Short bends on small pipes, such as $2\frac{1}{2}$ in. down to $1\frac{1}{4}$ in., should be made as follows: Warm them about 6 in. long on the part to be bent, if they are required sharp like Fig. 12, it is best not to dress in the sides first, but bend them a little at one time, allowing it to buckle in a little. This will do no harm in this case, because by allowing it to buckle in front it does not cause the back to stretch to any great extent. Now take the

large bolt, and if the pipe is large enough, place the large end in the pipe, and knock the buckle out with the large hammer. It will be found that the sides that were bulged out by bending are still projecting. These should now be driven down towards the back with a flat dresser. By this means the bend will be found when finished to be of even thickness. Most plumbers always dress the sides first whether it is to be made with the bolt or not, but with this kind of bend it is not necessary. Not only so, but it causes more labour, because it will be found that if the sides are dressed in first it not only causes the back to stretch more, but when the front or throat is being knocked out with the bolt, the sides will be drawn in, thus making more work for the bolt than otherwise would be necessary ; the result is the same if the sides are dressed back after the pipe is bent, if it is done before the bolt is used. Knuckle bends on service and waste pipes are very much better than the usual way of making branch joints for such jobs as Fig. 11. Instead of connecting the brasswork at right angles it makes a much better job to form a short bend on the end with the bolt and make what

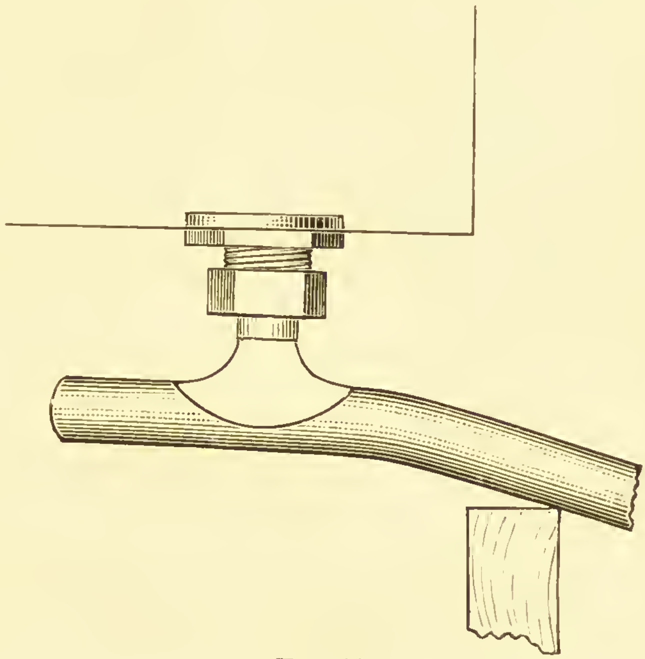

Fig. 11.

is called a knuckle joint. This plan allows any little obstruction, such as a piece of stick and many other things that are very likely to get down a waste pipe and cause a stoppage, to pass away if a bend is formed in the joint as shown in Fig. 12. In the case of services it makes a free passage for the water, causing less friction, especially if it supplies a W.C. or other fitting where a quick discharge is necessary. Of course, these remarks relate to circumstances where bends of larger radius cannot be adopted.

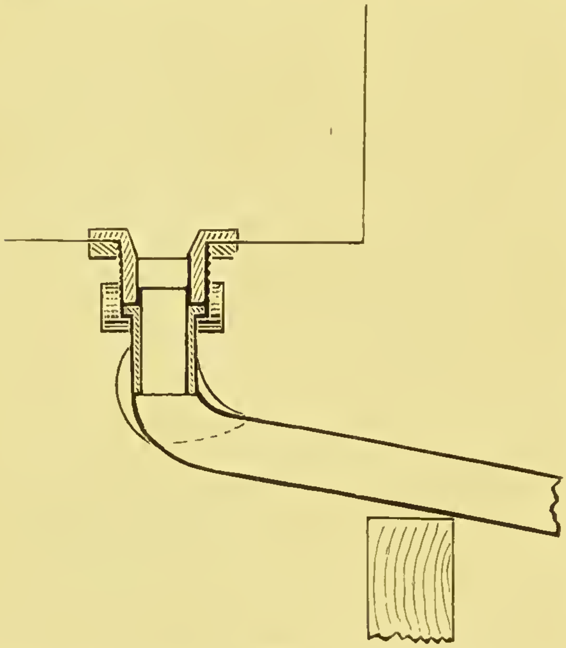

FIG. 12.

Service pipes generally should have as easy bends as waste pipes where it is possible to use them. The friction produced in services where they have to travel a long distance by sharp bends is very great, many of which cannot be properly called bends—they appear to have been pushed round the angles without the least care being exercised, thus reducing the way through them to two-thirds, and sometimes one-half of their proper size. This is virtually causing waste of material, for a pipe very much smaller in size would allow as much water to pass through if the bends were made to a larger radius. When bending services, however strong the pipe may be, it is always best to warm it if possible (say down to the size of 1 in.), then bend it, after which dress it each side towards the back. It makes a much better job to dress the sides

after it is bent, because if it is dressed first it will be very often found that the sides will remain flattened, and sometimes they will be drawn in more by the act of bending. If the sides are not dressed until the pipe is bent, they will bulge out a little, and thus enable the plumber to work the pipe to very nearly its proper size. If a felt or small piece of carpet is laid on the bend when it is being dressed, it will prevent the marks of the dresser being seen when the bend is finished. It also has a tendency to make the blows of the dresser more effectual in bringing the pipe to the natural shape, more than it would if the pipe is struck with the bare dresser, because the pipe is only affected where the face of the dresser comes in contact with it, but if the felt is used, it causes the blows to be distributed over a larger surface. The latter remarks also apply to larger pipes. It is much better to use a felt when the projecting sides of a soil pipe bend are being driven round to the back. It prevents the heavy strokes of the dresser from producing ribs or deep marks in the lead, which generally require a lot of labour with the dummies to work out.

Before leaving this branch of the subject, where heat is generally used for softening the material, it may be interesting to many to consider not only why we heat the pipe, but how it is that the application of heat renders it more malleable and ductile, thus making it more easy to boss or work it into whatever form it is required. Science tells us that all metals, or any other forms of matter, are composed of minute particles or molecules in close contact, so small are they that it is impossible to perceive them separately. These particles are held together by the force of cohesive attraction. When heat is applied the cohesive force is relaxed, thus permitting them to move more freely in whatever direction they are forced by the aid of tools or other means most suitable to the metal in use, with less

labour than otherwise would be required when it is at its normal temperature.

Or, to explain it more fully, heat is not necessarily fire, but what is scientifically termed molecular motion (or, as some term it, molecular activity). That heat is not necessarily fire, can be proved by hammering a piece of lead on a hard substance; the result will be that it will become so hot that the hand cannot be kept on it without pain to the person touching it. The consequence is that a piece of lead being composed of a great number of particles, on the application of heat these particles are so shaken about, so to speak, that they are loosened from each other and are thrown so far apart that the cohesive attraction has no longer the power to keep them together as it did before the heat was applied. The same cause will account for the expansibility of lead. Heat increases the bulk of bodies, or in other words, the body occupies a greater space when hot than cold.

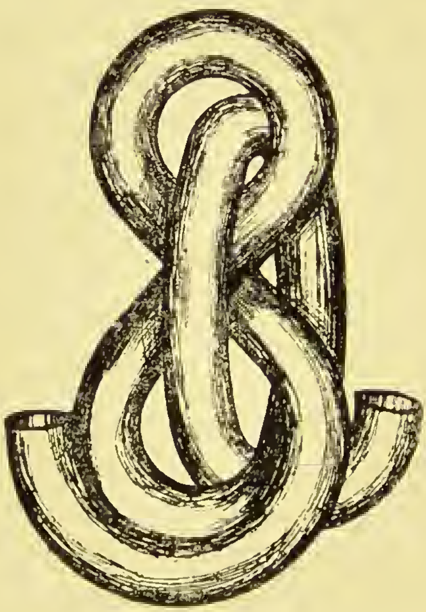

Fig. 13.

"As the increase of bulk depends upon, and is in direct proportion to, the amount of heat absorbed by the substance, expansion becomes a measure of temperature, or of that modification of heat, which is appreciable by the senses and susceptible of measurement by the thermometer." Fig. 13 is a rough sketch of a specimen of bending in 2 in. pipe; it was exhibited at the late Health Exhibition. I cannot say that it is drawn exactly to scale, because it was sketched from

memory. But it is a good illustration of what can be done with drawn lead pipe. The process adopted in making knots of this kind is to fill the pipe with sand and solder up both ends. Then, after warming the pipe and forming the knot by very easy bends, ropes are tied to the ends of the pipe, and the bends are made sharper gradually by the application of heat to the different parts while the two ends are drawn farther apart.

Great care is necessary in order to prevent the pipe bending too much in one place, because however well it is loaded inside, there is a probability of buckles forming if the bending is not continued gradually. The frequent application of the dresser is also necessary for the purpose of keeping the pipe round in section, otherwise it will spread out at the sides.

It need not be said that such a process is never resorted to under ordinary circumstances.

# CHAPTER IV.

## SQUARE PIPE BENDINGS.

SQUARE leaden pipes are very rarely used for soil pipes, nor should they be, for square or rectangular pipe is a very unsuitable shape for any pipe used for the purpose of conveyance of sewage or other dirty waste matters, whether they are fixed vertically or otherwise, although when certain kinds of architectural designs have to be carried out, the sanitary question is often left in abeyance. Sometimes square soil pipes are made to match iron rain-water pipes. Very often the plumber has to make up bends and set-offs of sheet lead to fit iron rain-water pipes. This is generally more economical and convenient than making patterns, and having them cast in iron, because they can be made on the job without delay. Lead has been used for square, rectangular, and half-circular rainwater pipes for many years. They may be seen on very old buildings, many of which appear to have been in existence for a century or even more. Lead seems to be the very best material for this purpose, especially if it is well fixed, in short lengths, with socket joints. I have seen old lead rain-water pipes and heads that have been in use nearly a hundred years that are very little the worse for their long exposure to the weather. This is accounted for by the fact that the surface of lead after being exposed to the atmosphere for a short time becomes oxidised. By this means a hard coating is formed, which prevents any further action either by air or water. This chemical action is very peculiar in lead. By combining with a certain quantity of its enemy, oxygen, it

forms its own protection.* The results are very different with iron pipe; instead of the oxide protecting it, it acts as a means of conveying further oxygen to the metal, and promoting its more rapid decay.† If further statements are required to show the advantages of lead, in the place of iron, for rain-water pipes, numberless cases could be produced from the experiences of any one in the building trades. Until very recently all square lead pipes had to be made up of sheet lead with a soldered seam at the back. But now certain sizes are drawn or milled in a similar manner to the drawn soil pipe. It has not come into general use yet, no doubt it will in a few years. Then all the plumber will have to do is to make and fix the sockets and astragals, and fix the pipe in the ordinary way on ears or tacks. The difficulty will be with the bends, these can be cut and soldered if they are required sharp. If they are soldered with the copper-bit the edges should be rasped to a feather-edge, so as to make room for a good body of solder, but the best way is to wipe them; this makes a more substantial joint, and will not require cleaning off if wiped evenly (Fig. 14). It will also become the same colour as the other part of the pipe sooner than if fine solder is used; this is a consideration if the pipe is not painted. If the bends are wanted very easy they can be made by warming them and bending them carefully, and

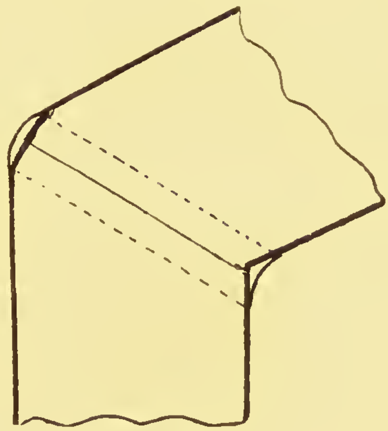

FIG. 14.

* The action is sometimes different under water.

† Galvanising only protects it for a short time, and when the zinc coating is eaten through the iron rusts more rapidly than it would if it had not been galvanised, owing to the chemical action of the two metals.

then knocking the irregularities out with a dummy, the head of which should be nearly flat, and one edge sharp to fit the angles, and the pipe dressed to its proper shape. There are many instances where the drawn pipe could not be adapted, especially where bends are wanted to match and fit rain-water pipes. In some cases it would have to be made a special size and shape; this would involve great expense where only a small quantity is required, consequently it is necessary to make them of sheet lead. There are several ways that the sheet lead can be cut to form the elbows or bends, as the case may be. It will, of course, depend upon circumstances as to which would be the best plan to adopt. We will first consider the way to cut out the lead, as it lies flat on the bench, so that it shall require little or no fitting when it is turned up. There are many advantages to be gained in this manner besides saving time and material.

Now, to make elbows in a proper manner, it will be a great help to the plumber to have some knowledge of geometry, or that part of it which relates to the development of surfaces, or so lining out the surface that when it is cut and the angles bent it will form the elbow without any further trouble. It is a noteworthy fact that the science of geometry is very little valued by plumbers generally; this is to be deplored, because there are very few jobs the plumber has to do but what can be arranged better and more satisfactorily with the aid of a knowledge of geometry, whether it be making up bends or covering surfaces. I would advise every young man who wishes to excel in his trade to make this (or any other part of science that applies to the materials he uses, or the better setting out of his work) his special study. If he does not, he will find the next generation outrunning him in the race for that state of efficiency which the great advancement of education will make possible.

But I think it necessary to add, he should on no account

neglect the more practical parts of the trade, because he is more versed in the scientific subjects. The latter remark is suggested by the fear that there is a reactionary movement taking place. Too much importance is being attached to theory at the expense of practice. There has been a great cry about the absence of technical knowledge in plumbers which undoubtedly is true, but why go to the other extreme and give all the encouragement to technical examinations, and devote none of the certificates and prizes to examinations in practical work?* I am afraid if this is continued we shall soon be having a class of men who know all about how the work ought to be done and why it should be done. But if this is all they know they

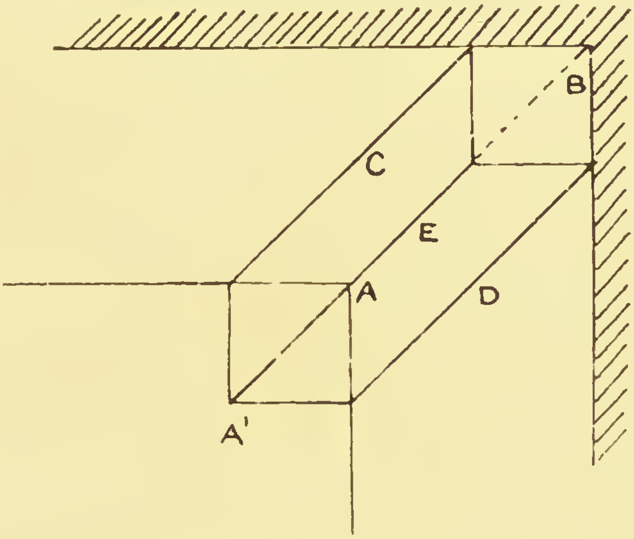

FIG. 15.

will be making putty joints, because they do not know how to wipe them, and their certificates will only be snares to those persons who cannot test their practical abilities. But to return to our subject. Suppose a plinth bend is required to be made of sheet lead to form a square pipe as in Fig. 16. A plan should be made to give the correct measurements between the two vertical parts where they are to fit in the angles of the walls. Now draw the plan of the pipe in the

* Since writing the above the City and Guilds of London Institute have made a rule that only those passing the practical examination can obtain a prize or medal.

angles A and B, Fig. 15. If the bend is only wanted to set over the plinth at any point except the angle, the plan would not be so much required. But coming in the angle the elbows will have to be made more acute than the true section of the plinth. Now draw the section of the plinth as Fig. 16, which will show the two faces of the walls above and below the set-off, and the height of one angle above the other, F and G. Draw a line at right angles to the face of the wall at F, and mark off the length from B to A, and $A^1$, Fig. 15.

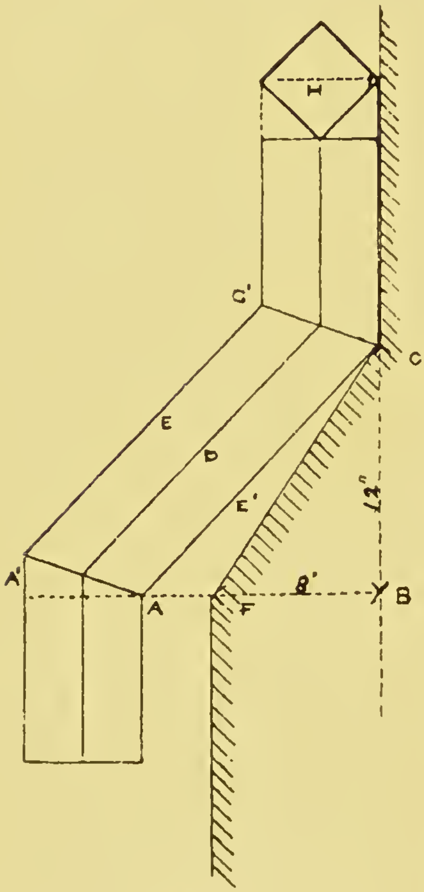


Fig. 16.

Now proceed to draw the elevation of the bend as follows: First draw the section of the pipe with its diagonal H at right angles to the face of the wall, this will make it more clear which side of the pipe is being shown; now draw the three parallel lines from the angles of the section down to the elbow G, draw a line from G to the point A and continue the two other lines D and E parallel to it to $A^1$, and then down vertical or parallel to the face of the wall as far as the pipe is required. Where the parallel lines intersect at the angles G and A, draw lines through them; these will show the joints. Supposing the pipe is wanted 8 in. longer than the elbows, a piece of lead should be cut out 2 ft. 10½ in. by 1 ft. 4 in. Now if

the soldered seam is made on the back angle, as shown at section H (instead of in the middle of one of the sides as is usually done), the piece of lead can be cut so that the whole of it can be utilised without causing any waste. In my opinion the best way to solder square pipe is on the angle, whether it is wiped or soldered with the copper-bit. By referring to the section at Fig. 17, it will be seen that the back edge of the side forms the angle, and the edge of

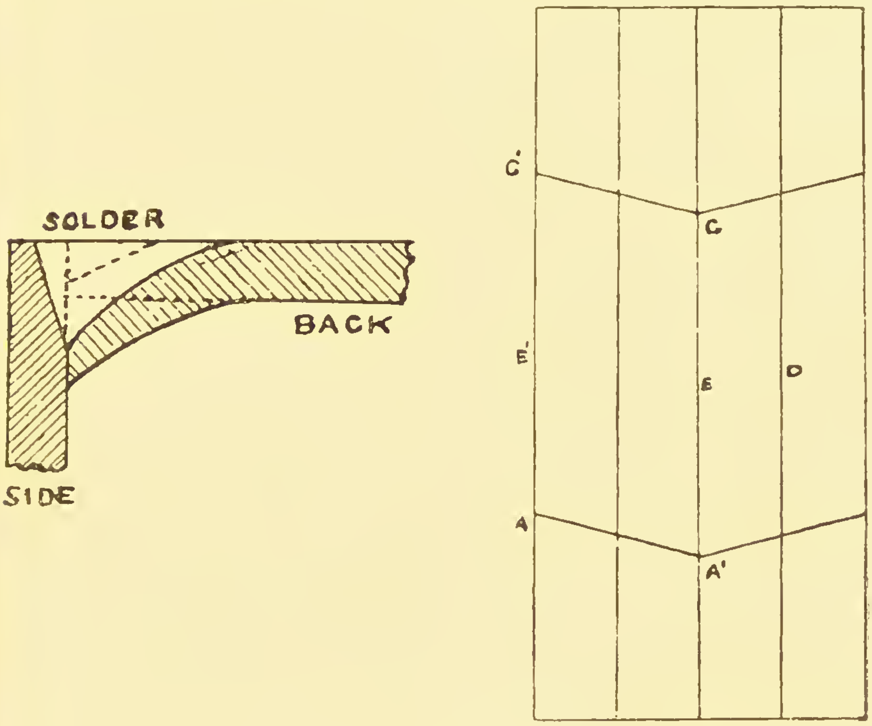


FIG. 17.

the back is turned down sufficient to form a channel or sinking for the soldering, or if it is soldered with the copper-bit (which makes a very good job) it is only necessary to level the bevel edge as shown by the dotted lines ; but if a stronger job is wanted, the edge should be turned in and the seam wiped.

Dress out the piece of lead on a hard smooth surface and strike three parallel lines 4 in. apart the whole length of the

lead, as in Fig. 17. Now mark the length from the top of the pipe to $G^1$, on the outside edges, from the top of the centre line mark the length from the top of the pipe to G; now draw lines to connect the three points given. From the centre point G mark the length from $G^1$ to $A^1$, now cut off the top piece on the lines G and $G^1$, then using it as a template bring it down until the point G touches A, draw the lines parallel to the edge at $AA^1$, and cut the bottom piece off to these lines. After turning the angles up to the lines and using the top piece for the bottom and the bottom for the top, they will be found to fit together and form the exact angle required. The elbows should now be soldered together, as shown at Fig. 14, if a good substantial job is required, but if the angles are to be finished sharp the edges should be feathered and well sweated with the copper-bit and fine solder and then cleaned off with a rasp and files. They can be soldered inside, but it is rather a difficult job, especially on the throat angles, unless a copper-bit is used; then the edges could be feathered inside. This will prevent the solder being seen on the outside. The latter plan certainly makes the neatest job, although it cannot be said to be the strongest.

While in one of the Midland towns a few years ago, I saw some square leaden rain-water pipes fixed on a large new building, the fixing of which was a disgrace to any one who had anything to do with them. There were several stone stringings running round the building, and where the rain-water pipes passed them on their way down to the ground level, instead of the stringings being cut through to allow the pipes to run straight, or elbows made to enable the pipes to pass over them, the lengths were fixed at the top ends, after which the bottom ends were pushed in close to the wall, and the next length slipped on and fixed, so that the lengths that passed over the stringings only touched

the wall at each end and the stringing in the middle. I cannot think plumbers had anything to do with fixing them, although they must have prepared them. Of course, the proper plan to adopt is to have holes prepared and the stringings formed to pass round the front of the pipe, or else a notch should be cut through from the front just the width of the pipe. But as we have to be ruled by persons in authority, it very often happens that the stringings are not allowed to be cut, as appeared to be the case in the instance mentioned above; and sometimes there are other obstructions, such as horizontal pipes running across the wall, so that it is often necessary for the plumber to make bends similar to Figs. 18 and 20.

Many plumbers will, perhaps, say that it takes more time and trouble to set the bends out geometrically than the usual plan of making the pipe up first and cutting the elbows with the saw; but this idea is a mistaken one, especially if the cuts are made by guess, as they very often are. Generally a rough measurement is taken, and then a piece of lead is cut out much larger than is really required; the pipe is turned up and soldered, then a gusset piece is cut out, and the two edges brought together, and taken to its position and fitted, then brought down and cut again; and so the process goes on until each elbow is fitted "near enough," and very often too near (I mean to the end); the result is, it has to be thrown aside, and a piece more lead cut out to make it long enough; consequently time and materials are wasted. This is no extreme case; it is done frequently by men who otherwise are good workmen.

Now, if jobs of this kind were set out in a proper manner in the first instance, it would not only save time and materials, but it would also enable the plumber to get each of the elbows the same angle, as Fig. 20, so that they fit together without any unnecessary soldering, and thus make a neater and better job of it altogether.

To set out a bend to pass over a stone stringing, Fig. 18, no plan is necessary. First draw a line showing the face of the wall, with the section of the stringing D projecting from it. Draw a line through the centre of the stringing at right angles to the face of the wall at $B^1$ F, this will give the joint of the middle elbow exactly. Now mark off equal distances top and bottom of the centre line at $A^1$ and $C^1$, and draw lines to connect the three points $A^1$, $B^1$, and $C^1$, according to the size of the stringing. The next thing is to get the lines showing the joints of the other two elbows. This is done by marking off points at equal distances each side of the point $A^1$. With these as centres, place one leg of the compasses on one point, and with any radius describe one of the arcs (or parts) of a circle at E, then from the other point mark the other arc, from the point of intersection draw a line to $A^1$, this will ensure both the ends of the pipe being the same angle; treat the other elbow just the same way. Now draw the front lines A, B, C, and E parallel to the back line, and the elevation will be complete.

The length of the piece lead required for this bend can be accurately obtained by measuring from the top of the pipe to $A^1$, and then across diagonally to B and down to $C^1$, and then to the bottom of the pipe. These four dimensions added together is the length required. The width, of course, is obtained by multiplying the width of the side by four, allowing about one-eighth of an inch on each edge for turning in at the seam. We will suppose this pipe to have a soldered seam in the centre of the back (as shown in the section), consequently two of the parallel lines should be half the width of the side of the pipe from the two outside edges, the other two lines will divide the remaining space into three equal parts, and represent the angles of the pipe. Now take the dividers (or compasses) and take the length from the top of pipe to $A^1$, Fig. 18, and mark it on the two

outside lines on Fig. 19, at the points $A^1$ $A^1$, draw a line through these points across the piece of lead, then mark the length from the top of the pipe to A on the two middle lines at A, connect the two points as shown, then from these two points draw lines to $A^1$ and $A^1$. Now, with one leg of the compasses on the point where the two dotted lines cross, mark off the two points at $A^{11}$ to correspond with the points at A, and draw the three lines as shown. This gives the first elbow. The middle elbow is obtained by taking the

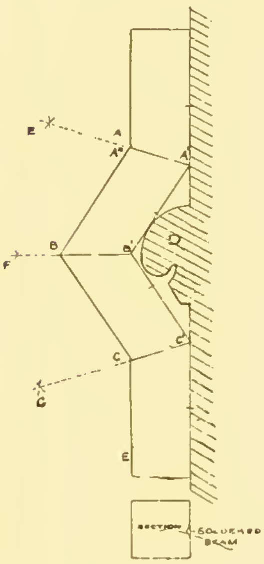

Fig. 18.

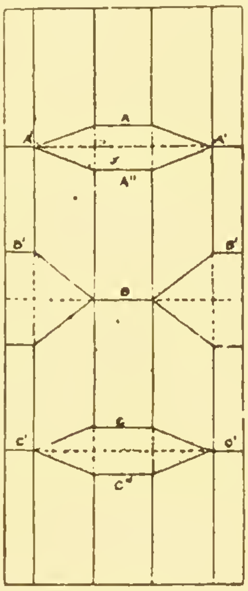

Fig. 19.

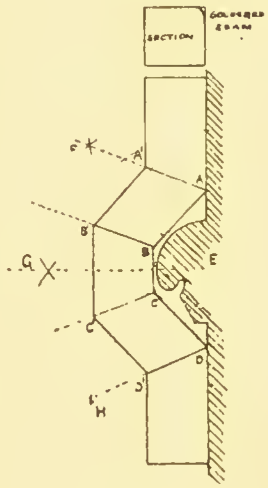

Fig. 20.

length from $A^{11}$ to B, Fig. 18, and marking it off on the two middle lines, as shown at B, and drawing a line across at right angles to the parallel lines. Now mark the length from $A^1$ to $B^1$, Fig. 18, on the two outside lines at $B^1$ and $B^1$. Draw the lines to connect the points as shown, and transfer the points to the lower side of the dotted line, and draw the lines to correspond with those as $B^1$, B, and $B^1$. Then with the leg of the compasses on the points of the line B, transfer the points; and lines at A, $A^1$, and $A^{11}$ at an equal distance from the line B, to C, $C^1$, and $C^{11}$, this will give the lower

elbow. After cutting out the pieces at A, B, and C, and turning up the angles to form the pipe, it will be found that the elbows will come together with no more trouble than filing the edges of the lead to the required angle, so that the edges will butt.

A few remarks will not be out of place here about turning up the angles of square pipe. It is the custom with many plumbers to score the angles on the inside with the point of the shavehook, so that they can be turned up sharp, and want very little dressing up afterwards. In fact, square pipe can be turned up this way without a mandrel, and has been done so frequently. The practice used to be very general years ago, as most of the old lead rainwater pipes will be found to be scored in the angles. Many plumbers condemn it, while others think it does no harm if it is done carefully. It certainly makes a neater job, and the angles can be made straighter than by working it on a square mandrel. My opinion is that if a shavehook is used with a nice round point, and about one-third of the thickness taken out of the lead, when the angles are bent, it causes the lead to thicken again very near to its proper substance, and as expansion and contraction have very little action on the section of a pipe, but rather on its length, I think it can do but little if any harm to the durability of the pipe. The mischief is done by carelessness in using a shavehook with a sharp point, and nearly cutting the lead through; this is quite unnecessary.

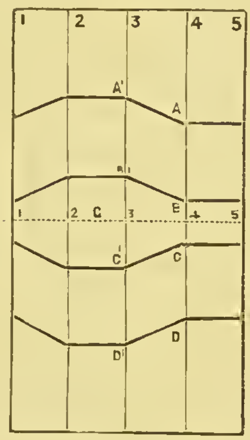

FIG. 21.

We will now consider how to cut out a bend to pass over the stringing, in a different shape to the last. As Fig. 20, this can be cut out so that there is no waste; each piece

can be cut into the angles of the other, as shown at Fig. 21. But to do so it is necessary that each elbow should be the same angle (that is not the case with Fig. 18). To do this we first draw the line of the face of the wall and the section of the stringing as described before.

Now draw a line parallel to the face of the wall in the front of the stringing at B C, then a line from A to B to any convenient angle. Place one leg of the compasses on the point A and mark off any distance on each side on the back line of the pipe with these points as centres, mark the two arcs of a circle at F, draw a line from F to A, this gives the joint of the top elbow. From the point B run out a line parallel to F A, giving the joint of the next elbow. Now draw a line through the centre of the stringing at right angles to the face of the wall to G. Draw the lines showing the outside face of the pipe (parallel to the back face) at $A^1$, $B^1$, and $C^1$. With one leg of the compasses on the line E G mark the same distances as $B^1$ and B, the other side of the line at $C^1$ and $C^1$, these two points connected give the next elbow. A parallel line to $C^1$ C, at $D^1$ D, gives the last. To prove this angle the same process should be adopted as at $A^1$ A. The lines from $C^1$ to $D^1$, and then down to the bottom of the pipe, complete the elevation. By measuring the length of the front line of the pipe the length of the piece of lead will be obtained. Supposing the seam to be on one of the back angles, we divide the width into four parts and draw parallel lines as Fig. 21, let the space $A^{11}$ represent the side of the pipe shown in the elevation. Draw the line through the centre of the piece at G, which will represent the line G E on elevation. Now take the length from the top of the pipe to $A^1$ and mark it off on lines 2 and 3, then from the top of the pipe to A mark off on lines 1, 4, and 5; connect these points with lines as shown, mark the length from A to B on line 3, cut the top piece off, and, using it as

a template, bring it down to point $B^1$, and draw lines parallel to the edge. With one leg of the compasses on the points 1, 2, 3, 4, and 5, line G, the points on the lines above can be reproduced below at an equal distance, cut the piece of lead in five pieces on the lines given, and after turning up the angles and reversing the positions of the pieces $B^1$ and $D^1$ they will fit together and form the bend required without any further cutting. The reason why the two pieces $B^1$ and $D^2$ are reversed is to prevent the waste of six small pieces, the size of which can be seen by reversing their positions before the lead is turned up. I would advise my readers to cut these bends out of thick paper or cardboard to any scale as shown in the figures, and turn them up and gum them together as an experiment. This will not only be interesting, but it will enable them to find out many ways of cutting out sheet metal, which will be very advantageous to young plumbers who have had but little experience in this kind of work, whether it be in lead, zinc, or copper.

# CHAPTER V.

## HALF-CIRCULAR ELBOWS.

ALTHOUGH elbows on half-circular pipe cannot strictly be called square pipe bending, yet as the process of developing them is very similar to that of square and rectangular pipes, and as the term is used more in its general sense to distinguish them from round pipe bending proper, it will not be inappropriate to introduce

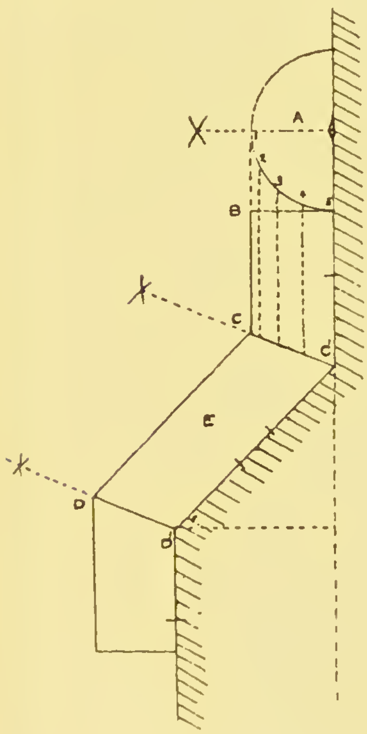

Fig. 22.

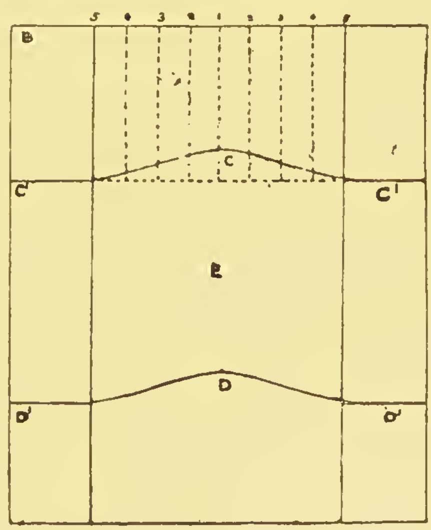

Fig. 23.

here an example of half-circular pipe bending, and in such a manner, that by cutting the lead on the principle described in Fig. 17, we can utilise the whole of the piece without

waste. This may not be important where there are only one or two bends to be made, but if several are required, and the material is limited, it is well to know how to use it to the best advantage, on the principle of "cutting the coat according to the cloth".

As it is necessary to make two elbows, so that what would be the waste piece of one can be utilised for the other, we will suppose another plinth bend on a pipe passing down a wall, and not in an angle. First, draw the section of the plinth, as Fig. 22, with the face of the wall above and below. Then, describe with the compasses a semi-circle, with its radius at right angles to the face of the wall at A, or at any point above the top of the pipe within the outside lines of the elevation, so that it shall represent the section of the pipe. Now, draw the elevation of the bend parallel to the face of the wall and plinth, leaving the top and bottom ends a convenient length to fit or socket into whatever they are required for. Prove the angles as described in the preceding chapter, so that both ends shall be the proper angle. Divide the lower half of the section into four or more equal parts; the greater the number of parts the more correct will be the curve. From these points draw (or as it is geometrically termed project) parallel lines down to the first elbow C $C^1$. To get the length of the piece of lead, measure the length of the front or back line of the elevation. The width can be obtained most correctly by cutting a strip of lead and bending it to the shape of the section of the pipe, allowing a little to turn in to form a sinking for soldering if it is to be wiped, A, but if the seam is to be soldered with the copper-bit, the edges can be bevelled off with a rasp and butted level. We are supposing this pipe to be soldered in the middle of the back, so that a line should be drawn half the width of the section from each edge, as Fig. 23, which will represent the two angles. Now

take the length from the top of the pipe to $C^1$, and mark it off on the two outside spaces at $C^1$ $C^1$; draw a line across the lead to connect these two points: above this line divide the middle space into double the number of parts marked on the half of the section. The centre point will represent 1 on the section, being the centre of the front of the pipe; now number the lines each side of the centre, as shown at Fig. 23, to correspond with the numbers on the section. Then take the dividers and mark off from the top of the piece of lead down the lines at C the lengths of the lines from the top of the pipe, Fig. 22 (not from the section), to the line showing the joint of the elbow C $C^1$. The length of each line to correspond according to the numbers on each figure.

These points should now be connected by a curved line being drawn through them as shown.

Take the length from the elbow C to elbow D and mark it on the piece of lead from $C^1$ to $D^1$ on the two angle lines, now cut off the top piece to the lines $C^1$ and C, then using it as a template place each end to the points $D^1$ $D^1$ and draw a line to correspond with $C^1$ C, cut the bottom piece off, and after turning it up to the shape required, invert the middle piece E, they will then come together and form the bend with very little fitting. It will be found that round or

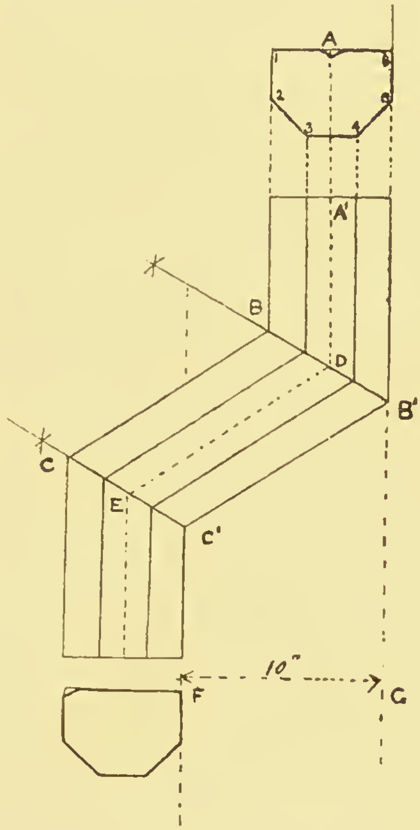


Fig. 24.

half-circular elbows cannot be cut by lines to fit quite so exact as those formed of square pipe, because the elbows of the latter are formed with straight lines. But, as already stated, the more the number of lines used to get the curve the greater will be the exactness obtained. Before leaving the subject of elbows, we will consider one more example of making elbows to form a bend on a pipe whose section is in the form of an irregular hexagon, having the appearance of a half of an octagon. Suppose a set-off is wanted to the left of the vertical line on a pipe fixed on a flat wall, as Fig. 24. First proceed to draw the elevation as shown by striking two parallel lines, F and G, to give the amount of set-off required, then show the section of the pipe at A. From the elbow B draw a line down to the elbow $C^1$ to whatever angle required. After drawing the lines B $B^1$ and C $C^1$, showing the joints of the elbows, and those at the other side of the pipe, draw the lines from the angles of the section, 3 and 4, parallel to the sides drawn to the elbow B $B^1$, and from thence to elbow C $C^1$, and then to the bottom of the pipe; these two lines will represent the two front angles, the outside lines representing the two back and two side angles. To get the length of the piece of lead required, take the dimensions from the top of the pipe to $B^1$, then across to the angle C, and from this point to the bottom of the pipe.

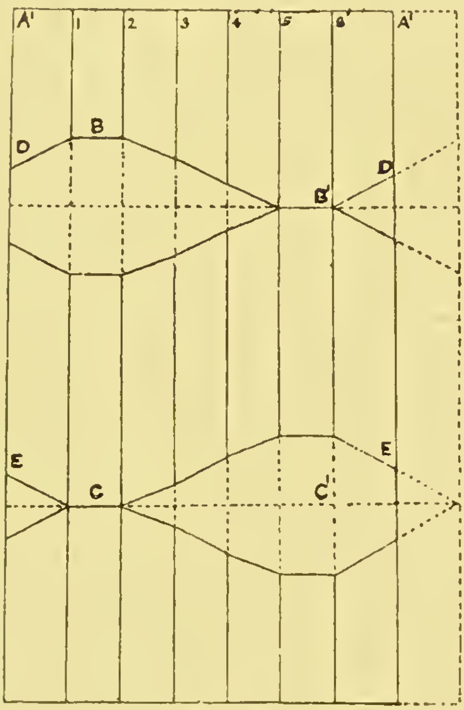


Fig. 25.

The width can be obtained by bending a strip of lead to the section of the pipe or adding the width of the six sides of the hexagon together. If the seam is to be at the centre of the back, as shown by the dotted line A, strike two parallel lines, half the width of the back, from the two outside edges. Then divide the remaining space into five equal parts to form the sides and front of the pipe. Now mark off on the two outside edges, from the top, the length from the top of the pipe to D. The length from the top of the pipe to B, mark off on the lines 1 and 2, and so on, as Fig. 25 indicates. Draw a line from the point $B^1$ at right angles across the piece of lead, also draw lines to connect the other points. Now take the compasses and mark off on the lines, below $B^1$, points to correspond with those above and connect them with lines as before. From the elbow $B^1$ take the length to $C^1$ and mark it off on the lines 5 and 6 as shown; by the same means mark the points on lines 1 and 2, at C draw another line across the lead. With one leg of the compasses on this line mark off the points above and below as before, draw the lines and cut the pieces out and turn them up to the angle lines and solder. If the seam is to be soldered at the angle, as shown at section F, the only difference is, instead of showing half the back on each side, it should be all on the right hand side of the piece of lead, as indicated by the dotted lines.

## CHAPTER VI.

### CURVED BENDS ON SQUARE PIPE.

MANY other examples could be given for cutting out sheet lead to form elbows, in addition to those already explained; enough, however, has been said to show the methods that should be adopted where elbows are not objected to, or

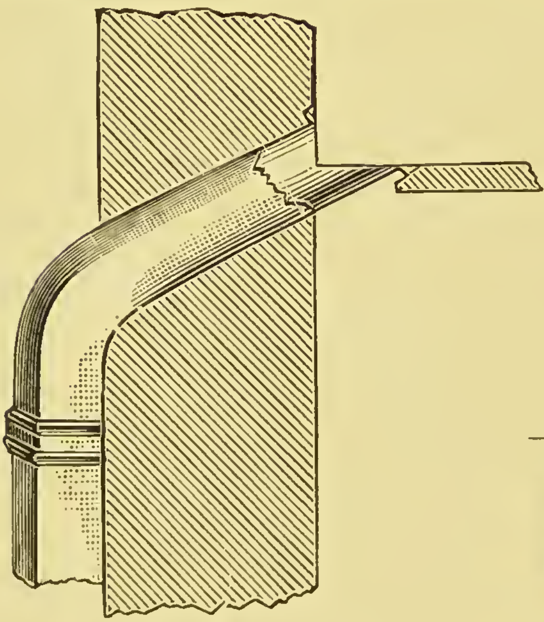

FIG. 26.

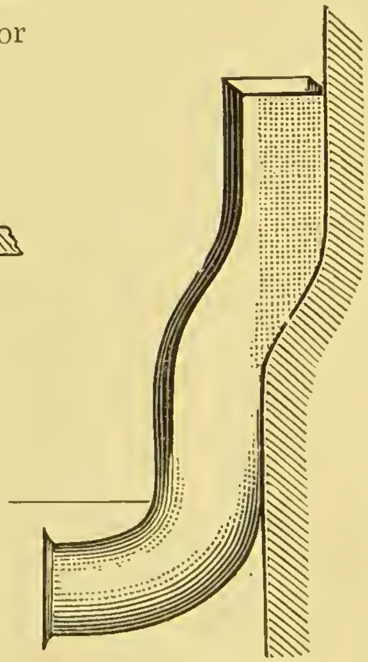

FIG. 27.

where they are most suitable to the circumstances of the respective cases. But where bends are required in the form of curves similar to those of round pipe bends, other means have to be used. These depend to a large extent upon the size and shape of the bends and set-offs, and what they are

wanted for. For instance, it often happens that socket pipes are required to convey the rain water from the cesspools through the wall to square iron water pipes, as Fig. 26. It is not necessary in this case to make up the pipe from sheet lead, but a much better job is made by bending a piece of round patent pipe in the ordinary way, and squaring up the bend where it is shown through the wall afterwards. This not only makes a better looking job than an elbow, but as it is not necessary for the pipe to be square in the wall, it is a much simpler job to make the joint in the cesspool in the form of what is commonly termed a bird's mouth. The pipe for making these bends should be equal (or nearly so) to the area of the square pipe; for instance, if the square pipe is 4 in. by 4 in., a 5 in. pipe should be used. And after the bend has been made with dummies, as already described, the angles can be formed by using a dummy with a square edge to it, while the outside is finished with round and flat dressers. It is a good plan to have a square mandrel with one end rounded to fit the back of the bend as shown in Fig. 28. Another instance where this kind of bend is very convenient is at the foot of a rain-water pipe, where a set-off is close to the ground line, and the pipe is connected to a rain-water drain or disconnecting trap. Here the connection is always required to be round, whether it is joined to the drain first or to the trap direct; Fig. 27 is an illustration of a case in point.

This really forms a lead shoe for a rain-water pipe, and if made the length shown by the dotted line, should be used in ordinary cases instead of the usual way of making good a square iron pipe to a round earthenware one. But if an earthenware bend is used, a short piece of pipe should have one end squared to fit the iron pipe, and the other left round with a flange on to fit the collar of the drain pipe. By this means a good sound joint can be made. Of course the best

job would be to have iron shoes made to the above description, but where they are not provided the plumber has to find a substitute.

Fig. 28 is a sketch of a double bend, one of which is round, the other rectangular. It represents a drain ventilating pipe passing through the front wall of a house below the cornice, and through a gutter; from this point it was carried up to the ridge with round pipe. In working these bends it is almost unnecessary to say that the bend to fit the rectangular or square pipe should be made first, this being the most difficult to make; it can then be worked from both ends with the dummies, both for making the bend and working out the angles. If a square mandrel is used, as shown by the dotted lines, it will save much time and labour, because instead of having to work the pipe to the shape with the dummies and dressers it is only necessary to form the square pipe roughly and then finish it on the mandrel. By this means the angles can be worked sharp and true without so much fitting and altering to get it to the right size to fit

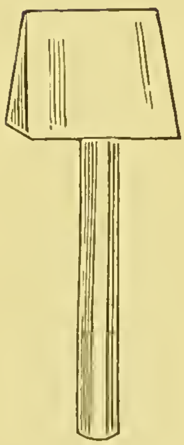

Fig. 29.

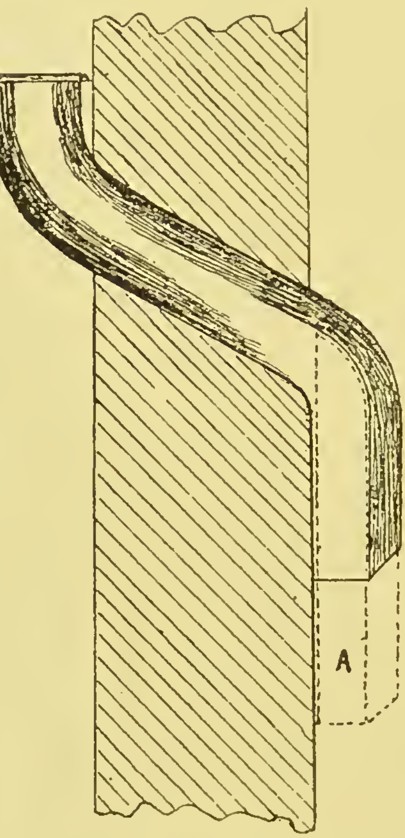


Fig. 28.

the socket of the iron pipe. When making the square-shaped bend, especially when the round pipe is not so large in section as that of the square, care should be taken to keep the girt of the bend very full, so that when the angles have to be formed it will not be necessary to distress the lead at the angles with the square-edged dummy, as shown at Fig. 29. If the circumference of the bend is worked to the same size, or a little larger, than the square pipe, it will only be necessary to dress the four sides flat to form the angles, and at the same time making them thicker and stronger. The above precautions are very important, not only where the pipe has to be squared, but in making ordinary round pipe bends. There are many plumbers who have a tendency to work their bends smaller than the proper size of the pipe. There is no excuse for this; it is just as easy to make the bends a little larger (when dummies are used) as it is to reduce them. In fact, all bends, when it is possible, should be made a trifle larger than the ordinary bore of the pipe. The reason is obvious, for a stoppage is always more probable in a bend or branch than anywhere else, so that it is always better to have the pipes larger at these parts than where they run straight. In some cases, after two or three bends have been made on a piece or a length of pipe, and it has been made to fit its position exactly, it is often impossible to get it into its place without cutting a lot of wood or brickwork away, or springing one or more of the bends and flattening them to a certain extent. Now if these bends have been made the exact size of the pipe, it is almost impossible to get them to the right size again. But if they are made larger at first, a little flattening will not do any harm, because they can then be dressed back in their place to the proper size or nearly so.

Among the several plans adopted for making bends or elbows on square lead pipe, none to my mind make a neater

or better job than that shown at Fig. 30. Especially is this the case if they are in connection with iron pipes, and where the bends are required curved and not in the form of sharp elbows, although they can be made almost any shape by this means. In fact, this plan can be used in more instances than any other, and very often with less difficulty. One advantage is that the material does not require so much working as some of the styles already described. The front pieces can be dressed and flapped nice and smooth, so that when the bend is finished the face is free from tool marks, which otherwise would look very bad after the pipe is painted, as is generally done, to match the iron pipe. The angles can be made to a sharp arris, like those on the iron pipe, thus matching it exactly. Although one cannot agree with painting lead pipes when they are fixed by themselves, because lead has a character of its own, which should not be covered up by anything that would deprive it of its substantial appearance; yet when lead has to be used as a substitute for iron bends, it should in this case lose its character and be made to look like that which it is supposed to represent. Fig. 30 shows a breeches pipe and bend in rectangular pipe, many of which are made to take the water

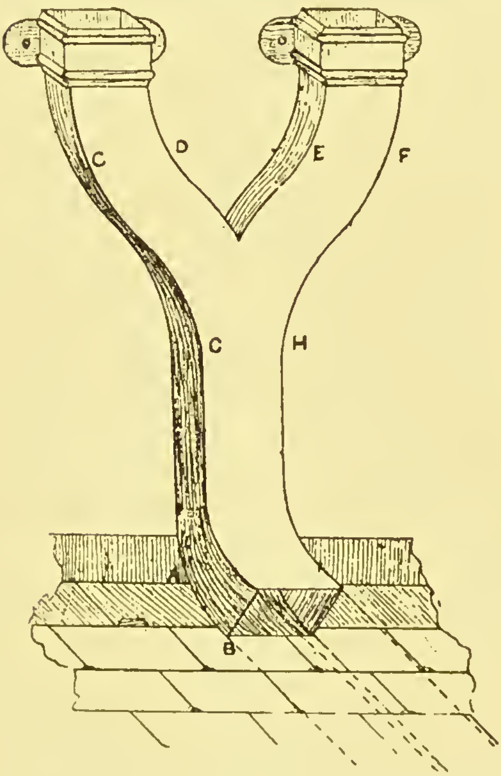


FIG. 30.

from two eaves gutters, one each side of a stone corbel, or some other projecting piece of stonework, and then discharge on a lower roof, or probably to connect with an iron rain-water pipe running down into a gutter below. A piece of work of this kind is not only simpler to cut out and make up, but it looks very much better than if it were made with elbows; certainly more soldering is required, but not so much more as some would think at first sight; if the length of soldering required to make the elbows and the seam down the back is compared with that required for the four angles, it will be found in most cases that there is very little difference between the two. Another thing in favour of the curved bend style is, that the kind of soldering used as shown in section Fig. 31 does not need any cleaning off, without the elbows are soldered inside; but this is very difficult to do generally. Some get over the difficulty by cutting a piece out of the back of the pipe at the elbow, so as to get the copper-bit inside, and soldering the piece in again after the joint is made, but this plan makes rather a rough job of it; at any rate, if compared with those made to curves and the front angles wiped, the latter certainly makes the best job. To make a breeches or a Y junction (as some would call it), like Fig. 30, the first thing required, if the drawing is not supplied, is to get the dimensions between the two arms, and from the top of the socket to the angle of roof and wall at A, strike lines to these dimensions as shown. The figure is shown in perspective so that the lower bend should be seen better, but the elevation to work to should only show the exact height and width of the face of the pipe, leaving enough length at the bottom to form the

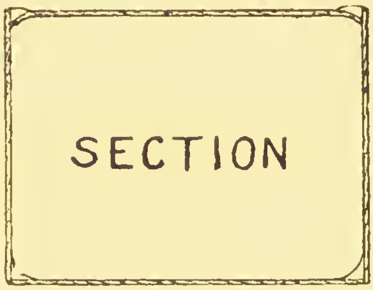


Fig. 31.

bend. To get the exact length and angle of the bend at the foot, a side elevation is required, as shown at Fig. 32; the length of the pieces of lead for the sides and top can be obtained by measuring the outside lines of the pipe down to the lowest point; now take the bevel of the roof and mark it on the bottom of the side piece; with any suitable radius describe with the compasses the curves A and B from one point as centre. The curves to the bends on the front elevation can be made to any radius suitable to the circumstances. Care should be taken to describe the curves C D and E F, Fig. 30, also G and H to corresponding centres and concentric arcs.

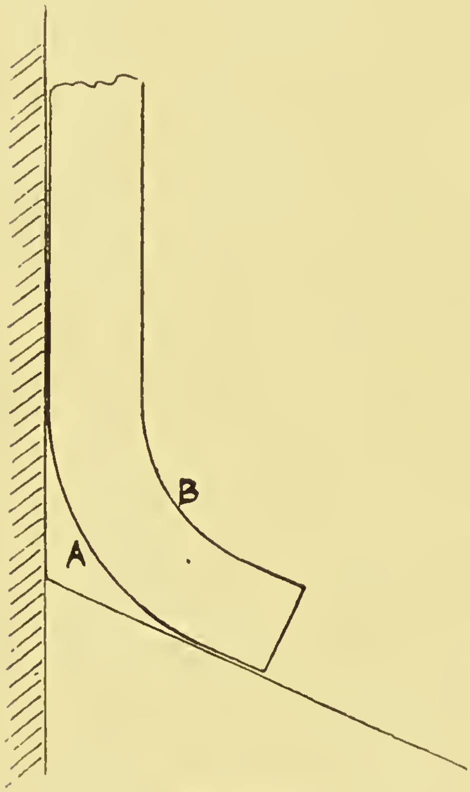


Fig. 32.

If several junctions the same size have to be made, the two first pieces should be used for templates to cut the other pieces by; the fronts and backs should be exactly the same width (allowing the back piece a little longer for the bend), so that one of each can be tacked together at the ends with the bit, and the edges rasped clean and even. Soil the inside of the front piece, and shave it about an inch wide from the edges, and lay it with the face downwards on a block of wood raised up sufficiently to allow the bottom end to be turned down to form the top of the bend at the foot; now soil the

insides of the side pieces, and shave them an inch and an eighth from the front edge; place one piece on edge on the block, and bend it to fit the shaved edge of the front piece, just in the same way as a band is fixed to the check of the old-fashioned D trap. If several of these bends have to be made, a piece of 2 in. board should be cut to fit round the outside to keep the sides firmly in their place while they are soldered, at the same time using a few thin wooden wedges, if they are required, to make up for any little irregularities; but if only one or two bends are wanted a piece of lead about 2 inches wide should be cut the same length as the side, and placed close to the angle that has to be soldered, and a few wall hooks or clout nails driven up close; the strip of lead will prevent the hooks or nails marking the lead, and also strengthen the angle while it is being wiped.

Care should be taken to get the edges of the sides perfectly straight by planing them with a jack plane on the edge of the bench; this will ensure the angles being regular and clean. There is one other precaution it would be well to take, that is, to soil the two outside edges before soldering, to prevent any solder tinning outside if it should happen to run through, although it should not take place if the edges are made to fit properly. The backs can now be soldered on by wiping them, or with a copper-bit seam. I do not think it is necessary to wipe these seams, because being in the form of a flat seam, if the edge of the back is bevelled or turned down a little, a good body of solder can be floated in. This makes a good job with less trouble than wiping; it also does away with the necessity of fixing struts inside, without which the wiping would be very difficult to do. I am not in favour of copper-bit work generally, because it is liable to a large amount of abuse, and when in the hands of unskilled persons, it is the cause of much mischief to the trade. But when used with discretion and skilfully

manipulated, it is very useful, and in many cases of great advantage, several of which we shall notice in further remarks on other subjects. In the case we have in hand, if the back is to be soldered with the bit, the back can be laid in and tacked with the bit, first about every four inches, then after the sides are dressed tight and the two edges burred close with the point of the compasses, the solder can be floated in without any further trouble, the copper-bit only causing the heat to be applied in a very small space; the back is not liable to fall through while it is being soldered, whereas if it is wiped, the whole or a much larger length is heated, and a greater weight of solder is required, which renders it necessary to block or strut the back up from inside, and also to strut the sides in, to keep them together. Of course the front angles could be soldered with the bit, but as it would be necessary to alter the position of the bends to solder them properly inside, it is much easier to wipe them and make a much cleaner seam.

# CHAPTER VII.

## BOSSED BENDS.

THERE is no other metal having the durability of lead that is likely to supersede it, in its adaptability and the facilities it affords for being worked or bossed and cut up into all manner of shapes and forms. It matters little how intricate the surface is that has to be covered, or the twists and turns that are required in the pipe, let it be square, round, or any other shape, if a piece of lead is placed in the hands of an intelligent practical plumber who knows what can be done with it, he, to use the common parlance, "can put it where he likes". Doubtless the metal which approaches the nearest to lead in malleability and ductility, is copper; the physical properties of which render it possible to be worked into various forms, both artistic and useful, and in most cases it exceeds lead in durability. But if it is required to cover carved surfaces, or to take the form of anything for which it needs much bossing, it is generally necessary to use special machinery and tools that would be very difficult to use on new buildings and many other more inconvenient places. Whereas, if the plumber has two or three boards for a bench and a few very unpretentious-looking wooden tools, he can boss a piece of lead into almost any shape, and in a comparatively short space of time, without taking it away from the building for which it is being prepared. When several jobs of a similar kind are wanted it makes a much better job to have a wooden mould made to work the lead on, although this is not always

necessary; there are many pieces of work that can be prepared with the tools alone. If a junction in square R. W. pipe, like Fig. 33, should have to be bossed so that the front and sides are in one piece, it will be readily understood that a solid block or mould would be required the exact shape of the junction so that the piece of lead could be worked over it, after which the mould is taken out and the back soldered on as before described. It is possible to work it all in one piece, and have one seam at the centre of the back; but to

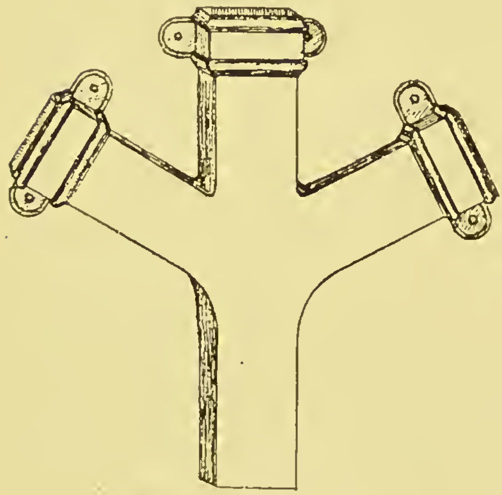

Fig. 33.

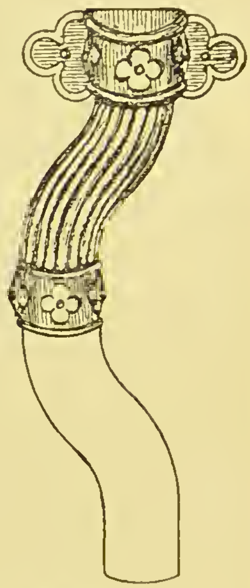

Fig. 34.

do this the mould would have to be made in three or more pieces so that it could be drawn out afterwards. I should not advise any one to do it that way, because it would not only be very difficult to work the material and keep a proper thickness, but no advantage would be gained in proportion to the extra time expended upon it. The only argument in favour of the latter plan is, that less soldering would be required than that described in the previous chapter, not that the extra soldering makes it more expensive, because as

a matter of fact it does not; the time saved in making it up and the very small amount of apparatus and tools required render it far more economical. This is a matter that should be considered by plumbers, as well as any other branch of the building trades, so long as the efficiency and durability of the work do not suffer in consequence. No advantage is gained in the long run to the journeyman by making the work expensive simply for the sake of causing more work. What is apparently lost by doing a job economically is more than regained by the extra demand which generally follows, when work is produced at a reasonable but not at necessarily a cheap rate. If the bend is required for pipe with an ornamental front, similar to Fig. 34, or say a square pipe with a moulding in the angles, or in any other form except those with square angles, it would be a very difficult matter to work them without a proper block made to the pattern required. But with a block it is a very simple matter to boss the lead so as to form the front and sides, then to trim the edges off to the back edge of the block and solder the back on as before described. This is far the best plan in the case of Fig. 34, because if it was worked in one piece the block could not be taken out without spoiling the shape of the bend by pulling it open at the back and causing much trouble and difficulty to get it to the right shape again.

When the bend or set-off is made on a block, the moulded sockets (or astragals as they are called on round pipes) can be formed in the same piece of lead, but if the bends are made up in four pieces the sockets are generally made separately and soldered on afterwards. To work these mouldings properly, it is best, where there are several to make, to have an oak or some other hard wood mould made to match the socket, a section of which is shown at Fig. 35. It should be long enough to work, sufficient to make the

front and the two sides. Instead of nailing the edges of the piece of lead to the side of the mould, it is a far better job to have two hard wood strips about $\frac{3}{4}$ of an inch thick, so that after the piece of lead is placed roughly on the mould and the edges turned down, the strips can be screwed on to the sides A, thus holding the lead firmly while it is being worked with the dressers and chase-wedges. Another improvement is made by having a stout piece of wood B to fit in between the two round nosings so that it can be screwed down tight at each end after the centre part has been formed. This will prevent the centre rising up when the outside mouldings are being chased, as it is sure to do if some means are not used to keep it down to the mould. There are several means adopted to make these mouldings.

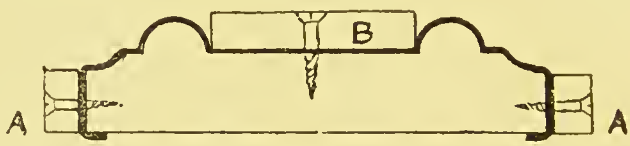


FIG. 35.

Sometimes they are cast in sand, lead, or iron moulds, but when they are required for pipes made up of milled sheet lead, none, to my mind, make a neater or more suitable job than the process described above. It certainly makes a cleaner job than casting, especially if no extra strength is required; but if they are wanted heavy, and a larger body of metal in them, the best plan is to make a lead or (if a larger number of them are wanted) have an iron mould made to the size required and cast them. There is another very simple and convenient but effective plan for making a moulding to match the usual pattern of sockets on iron rain-water pipes. I have adopted it in several instances, especially where only one or two sockets have had to be made, there not being enough of them to necessitate a

mould being made as described above. Fig. 36 shows the process. Take a piece of lead about two inches wider than the depth of the socket, and long enough to form the two sides and front, or, if it is a round pipe, a little more than three times the diameter; strike two parallel lines down it to represent the two angles A and B; now take a sharp draw knife and cut the lead about two-thirds through on these lines; turn the two side pieces up at right angles to the middle piece as shown by the dotted lines. Now fill up the cuts at A and B with the copper-bit and fine solder; this will form the angles and strengthen them so that when the hollows are being worked the angles will remain sharp.

Now place it on the bench as shown in sketch, with a

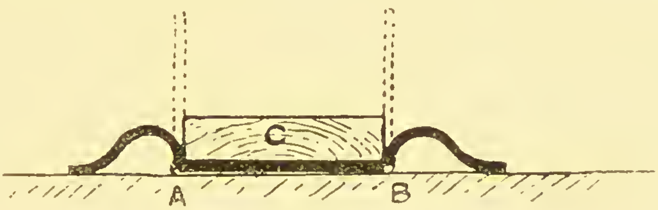


FIG. 36.

piece of wood nailed or screwed down in the centre C to keep it firm, then bend the two sides down so that the outside edges touch the bench, and with an even round-edged dresser and mallet work the hollow into the form required, and trim the two edges off to the right width afterwards. It will be found, that owing to the cut angles being filled with solder, there is no necessity to place anything round underneath, to form the nosings, if the hollows are worked carefully. I should not recommend the adoption of the latter plan generally, but only where one or two are wanted to take the form of the common pattern on iron pipes. It makes a much better job than the usual plan of cutting down a piece of half-inch pipe, and soldering it round the socket to form two half-round mouldings.

## CHAPTER VIII.

### CURVED PLINTH BENDS.

THE way to cut out sheet lead to form elbows in square and other pipes passing over plinths in an angle or otherwise has already been described. But there is one kind of angle plinth bend we have not yet considered, which to a plumber who has had but little experience in this kind of work will be found very difficult to make, whether it is made in the form of curved bends or sharp elbows. We will suppose a rectangular pipe about 6 inches by 4 inches coming down angle and passing over a plinth projecting from the line of the main wall 9 inches (Fig. 37). If the bends are required in the form of elbows, the pipe can be turned up and the elbows set out in a similar manner to that hereafter described; but as the curved bends are the most difficult, we will consider that way first. Generally where plinth bends are required they are in sight, and near the ground-level, so that it is necessary to make them as clean and smooth as possible. Therefore it would not be wise to make them by bending patent round pipe and square them afterwards, because, owing to their peculiar shape, they would require a very large amount of labour to work them up and make them look smooth. Although it is more difficult to set out a bend for rectangular pipe than it is for a square one, yet it is not nearly so awkward as it appears at first sight—that is, if a few lines are used to properly set it out. If a plumber attempts to make one by rule of thumb he will find it a very difficult job indeed. In fact, one is at

a loss to know how a plumber will start on a job like this, if he was not acquainted with some of the elementary rules of geometry.

The usual plan is to make up the pipe the required size and cut it roughly into lengths, after which the ends are cut —a small piece at a time—until they are made to form elbows. But suppose the architect wishes to have bends instead of elbows, the latter plan would not do at all. Therefore, where curved bends are required, it is necessary to adopt the following plan or one similar. Of course more elaborate or probably more exact plans can be used for the same result.

But my object is to make this kind of work as simple as possible, and to avoid all unnecessary technicalities and complications.

But to proceed. The first thing required is a smooth board or bench upon which to set out the bend, and the pieces of lead to form it. If a board large enough cannot be obtained, it can be set out on a piece of drawing paper to a smaller scale, and then enlarged again on the lead to be cut out. I do not recommend the latter plan, because it would take too much time and trouble, although it is very good exercise in drawing to scale.

First draw the section of the plinth, with the pipe passing over it, as Fig. 37. Now draw the plan of the plinth with the diagonal or mitre line, H to D, at right angles to the side of the board or paper; also draw the section of the pipe in the angles as shown in Fig. 38. From the angles of the plan of the pipe draw perpendicular lines parallel to each other down the board, long enough to include the length of the plinth bend. These lines are what are termed in geometry projectors, and are used for drawing plans from elevations or *vice versâ*. The lines from E and D represent the two external angles, the intermediate lines show the other angles of the pipe. At a convenient distance from the

plan draw a line across the projectors at A′ B′ C′ D′ to represent the top of the bend, Fig. 37. From the point D′ mark off the length required to the first bend D″; from this point on the same line mark the depth of the plinth at I. Draw a line from this point at right angles and through the projector line H, now connect the two points D″ and H′ with a line as shown. This triangle D″ I H′ shows the section of the plinth through the mitre line H D. Now take the compasses and place one leg on point H′, with the other mark off equal distances each side, as shown. With these points as centres, and any convenient radius, describe the arcs at K; from the point of intersection draw a line through H to the projector E′. This line will give the angle of the bend exactly. Repeat the same process at A″, drawing the line to J, which will give the angle of the upper bend. From the points where the lines J and K cross the projector lines at A″ B″ C″ D″ and E′ G′ F′ H′ draw lines as shown. We have now an elevation of the plinth bend sufficient for the purpose of cutting elbows; but as we require curve bends we must proceed further.

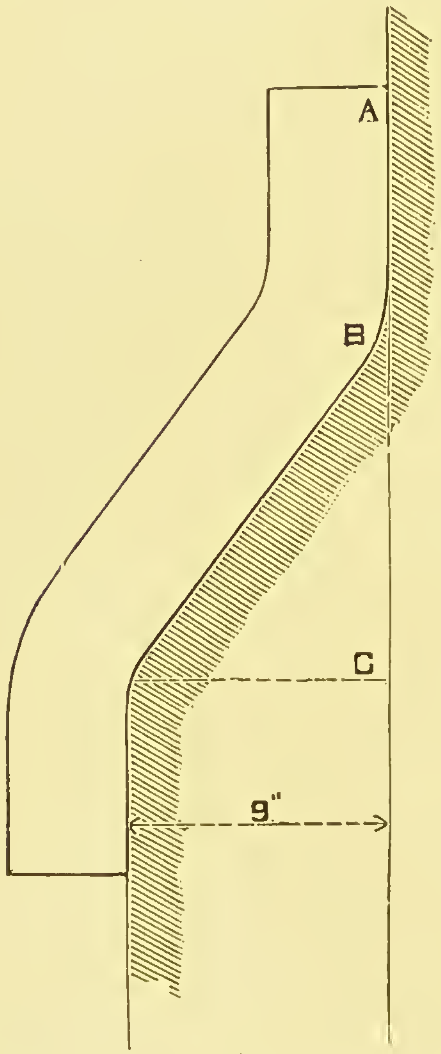

Fig. 37.

Now take the compasses set to any suitable radius,

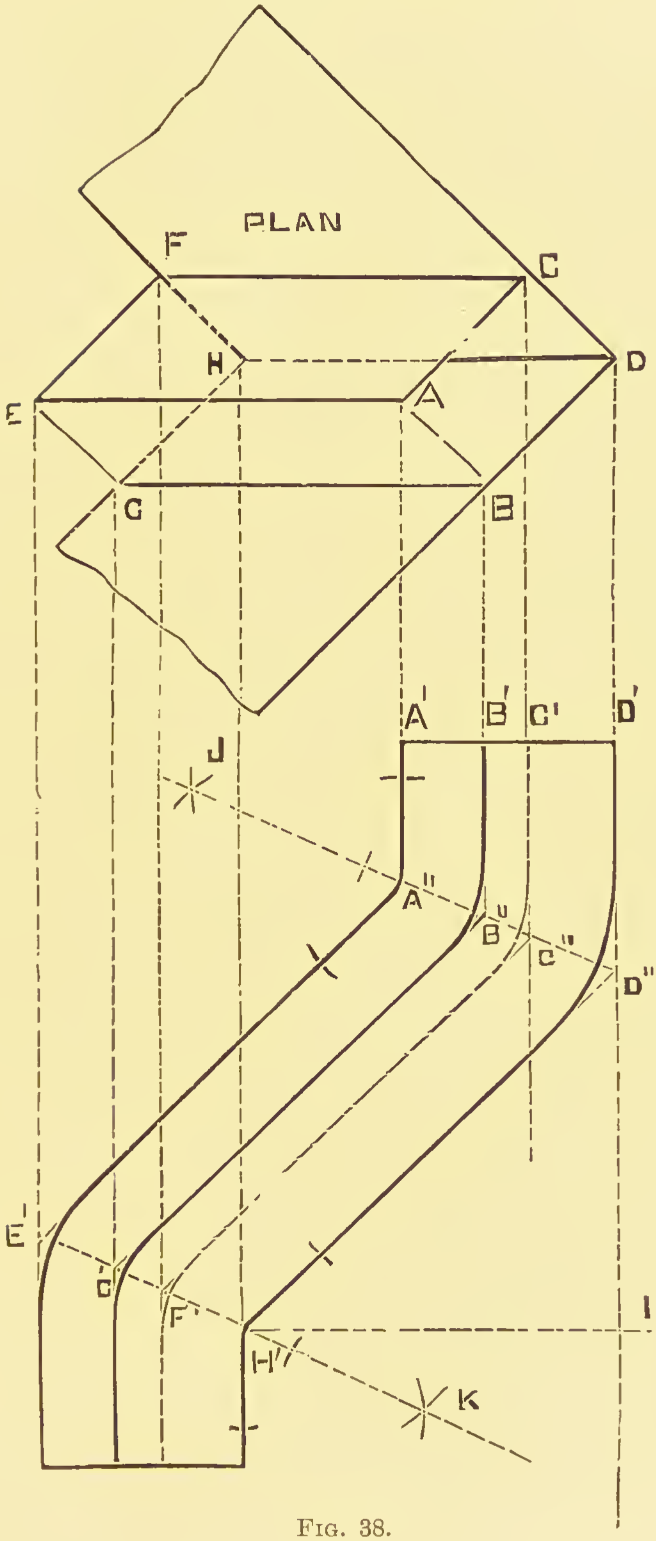


FIG. 38.

according to the circumstances of the case, with one leg on the line J as a centre describe the arcs at the angles A″ B″ C″ D″, using the same centre to each arc (or curve). Mark the centre these curves are made from, because they will be wanted for finding the radius of the curves on the pieces of lead that are wanted to form the bends.

Draw the arcs at the lower bend at E′ G′ F′ H′ in the same manner as described for the bend above.

Draw a line across the projectors at the bottom according to the length required below the lower bend.

We have now a sectional elevation of the plinth bend through the line H D on plan (Fig. 38). It is well in working this out, to suppose the bends are to be made in the form of elbows at present; therefore the lines showing the elbows should not be erased after the curves are made; because it does not matter to what radius the curves are made, the pieces of lead to form the bends must be set out from dimensions taken from these angle lines, or rather where the lines intersect.

When the elevation is drawn, it is a simple matter to set out the pieces of lead to form the bends. Dress out the lead on a hard smooth surface with a lead flapper. A smooth cast-iron plate is a good thing for this purpose.

Now strike a chalk line down one side of the lead to represent the dotted line from D (Fig. 39). To set out the widest sides first: Take the length from D′ to D″ on the elevation, and mark it on the line in Fig. 39; strike another line parallel to it, and the same distance from it as from B to D on plan, draw a line from B′ to D′ showing the top of the piece of lead. From B′ mark off the length from B′ to angle B″ on the elevation. Now draw a line from the point D″ through the point B″ to B, this gives the angle of the first bend. The continuation of these lines must be at the same angle from the line B″ to D″. To make sure of this, take

the compasses and place one leg on point B″ with any radius, describe the semicircle through points 1, 2, and 3. Now set the compasses to the points 1 and 2 and describe the arc at 3. Draw a line from B″ through the point of intersection at 3 down to G, draw a line parallel to the last

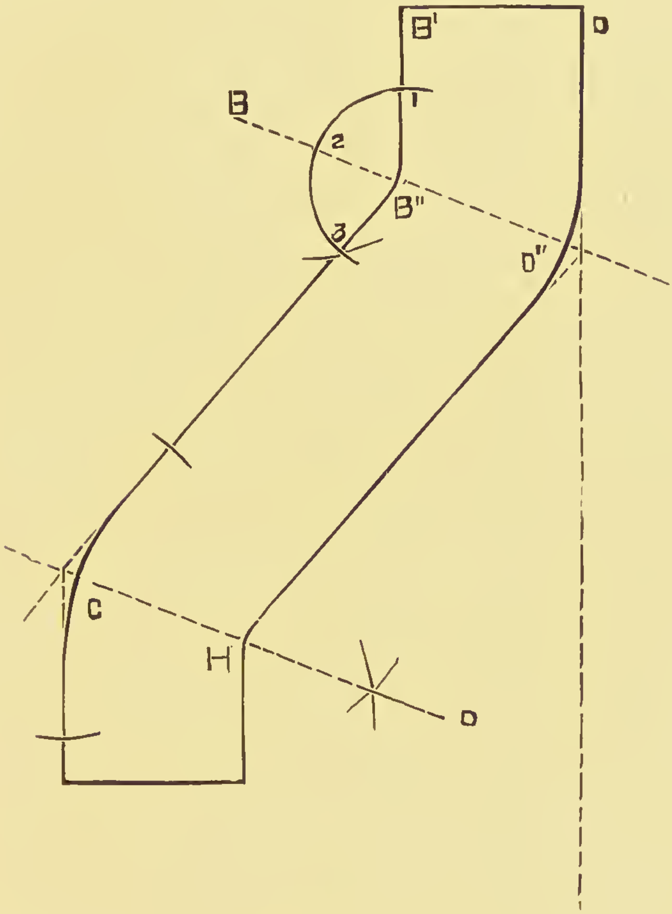


FIG. 39.

from D″ to H. Take the length from the point B″ to G on the elevation, and mark it off on the line B″ G (Fig. 39). From G draw a line down to the required length below the bend and parallel to the first line drawn from D′. To get the mitre line for the lower bend, place one leg of the

compasses on point G, and with any radius mark off equal distances on the lines each side. With these marks as centres describe the arcs at D. From the point of intersection draw a line across the line at H to G, this line should be parallel to the line through the upper bend from D″ to B. From where the dotted line from D passes through the line at H, draw a line down to the bottom of the pipe as shown. On looking at the plan it will be seen that the curves of the top bend are external, and those of the bottom one internal; therefore the radii of the curves are not the same, because, although the curves were made from the same centre, the edges that form the bend of the piece of lead we are now setting out are nearer on the centre at the bottom bend than they are at the top. To get the radius at D″ (Fig. 39) place one leg of the compasses on the centre from which the curves were described on the elevation on the line J, place the other leg on the point of the angle D″. With this for a radius place one leg on the line B and describe the curve at D″, from the same centre describe the curve at B″. For the radius of the bottom curves proceed in a similar manner. By taking the distance from the centre on the line K of the elevation to the angle at G with this as the radius place one leg of the compasses on the line D, and describe the curve at G (Fig. 39), and then the curve at H from the same centre.

Now rub out the lines that represent those that are dotted on Fig. 39, and cut out the piece of lead. This can be used as a template to mark out the piece for the opposite side, as this piece will be exactly the same size and shape as the other—the only difference is, it will have to be turned upside down. There is no necessity for me to explain in detail how to set the narrower pieces out, because it would only be a repetition of what has already been stated concerning the wide pieces. They should be

set out in exactly the same manner as described for the wider sides, by getting the dimensions from the points indicated by the letters on each figure. The plan gives the width of the lead, and the elevation shows the lengths and gives the angles or (as they are generally termed) bevels.

Before bending the lead in the form required, they should be prepared for soldering.

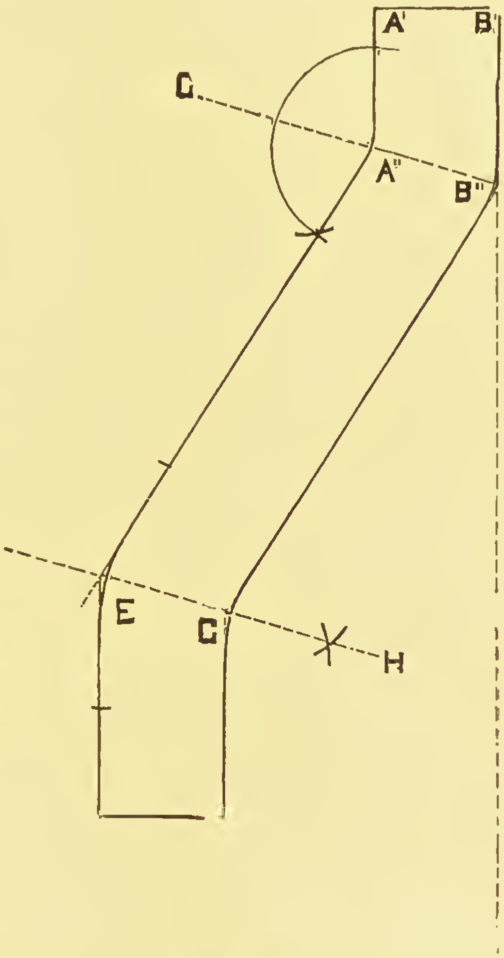


FIG. 40.

There are several plans adopted for soldering these bends together: sometimes the two front angles are soldered inside with the copper-bit, after which the back is soldered on the outside with a flush seam. To solder them in this manner, the edges of the front piece and the sides should be cleaned up, and soiled on the inside, and shaved about half an inch wide. They can then be tacked lightly together with the bit, care being taken to place the right edges together, by referring to the letters on the drawing, and placing the corresponding letters together. When it is properly fitted together, allowing the edges of the side pieces to come flush with the front, float a good body of solder neatly in the angles, with a large hatchet bit. After this is

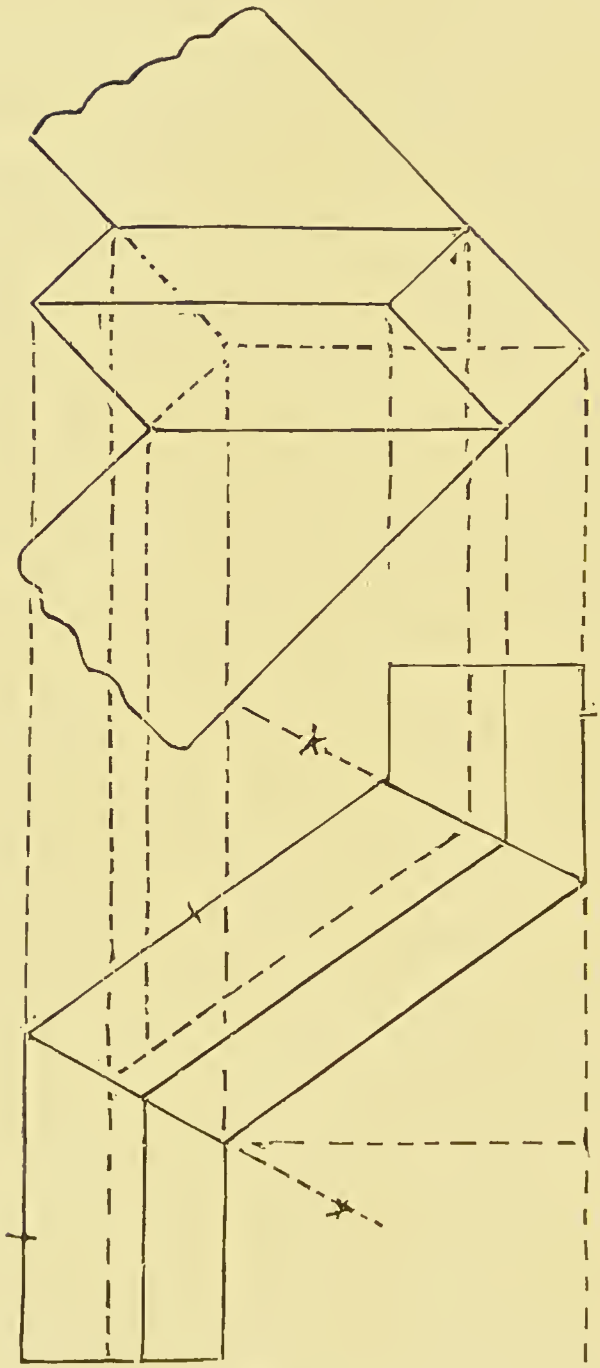

Fig. 41.

done, soil the back edges of the sides, and shave the edge, and about an eighth of an inch on the inside. Soil and shave the edges of the back piece about three-eighths of an inch wide, and let it in flush with the back edges of the side, tack it in several places with the bit. Then draw the point of the compasses down the seam to burr the edges together, and float a neat seam with the hatchet bit. The front edges can now be cleaned off, and finished ready for the astragal socket and ears.

Fig. 41 shows the way to set out a similar plinth bend having sharp elbows instead of curves.

It will be noticed that the lines are almost exactly the same as those at Fig. 38, but the curved lines on the angles are omitted.

The process of developing the surface, or, in other words, setting out the sheet lead, is the same in every respect as shown at Figs. 16 to 21, and the soldering can be done in a similar manner.

# CHAPTER IX.

## RAIN-WATER SHOES ON SQUARE PIPE.

IT was not my intention to explain such a simple matter as a shoe for a square or rectangular rain-water pipe, because one would suppose that any one with but a slight knowledge of the trade could do such an easy job as that without any difficulty. Many will say: "Surely any

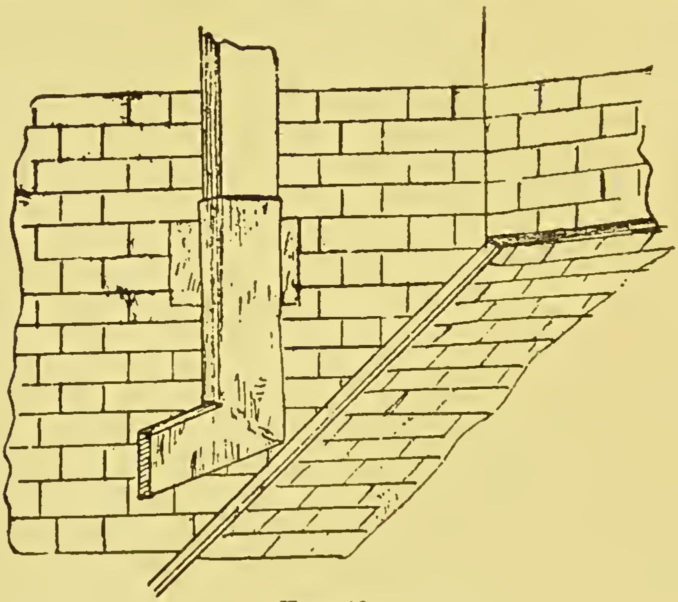

FIG. 42 A.

apprentice or improver could cut out a piece of lead to form a shoe to any angle or shape required without a moment's hesitation". I used to think so too; but on further consideration, and after remembering several jobs that are to be seen at different places, such, for instance, as that sketched at Fig. 42 A, my conclusion was that nothing was too simple

or commonplace. Some will be instructed, or, at any rate, interested, especially if they have not had many of the kind to make. Many that may be considered first-class plumbers go about a job of this kind so awkwardly and clumsily that one wonders what they have been doing all their lives not to know how to do such an easy job in a proper manner. Some, of course, do not take the necessary care to make a job look decent. Now nothing looks worse than to see work done in a slovenly manner, especially when it is situated outside the house where it is in sight of every one. The sketch at Fig. 42 A is a good illustration of a cheap, careless style of doing work. The shoe was evidently made of very thin zinc. The angle of the elbow must have been guessed at, or if it was designed in that style, the plumber surely had some ingenious idea in his head, which it would probably be difficult to discover. Perhaps the intention was to throw the water off the roof instead of allowing it to discharge on the slates, which was a good idea under the circumstances (providing no one was passing at the time). As there were no flashing or soakers on the roof, but only a cement fillet, it is very likely they were afraid the water would wash the cement fillet off, and run in between the slates and the wall. Whatever the intention was, one thing is certain, before very long the wall will be found saturated with water, and a large damp patch will be seen on the inside of the house, spoiling the wall paper, and causing far more damage than could be repaired for the sum required to execute the work properly in the first instance. In all cases of this kind it is indispensable that a lead (or at least a zinc) step-flashing should be fixed, covering the slates, as shown in Fig. 42 B, or to make a far better job, soakers should be laid under every slate and turned up the wall about two or three inches. A step-flashing should then be made to lap the soakers and be trimmed off about half an inch from the

edges of the slates. If flashings of some kind are not fixed, a rain-water pipe should not be discharged on the roof at all. In fact, it is not considered a good job in any case to allow a rain-water pipe to deliver on slate or tile roofs; they should always be continued down into a head or gutter, and then a shoe fixed to discharge the water in the same direction as the fall of the gutter, or into the head.

I have known several cases where the former plan has

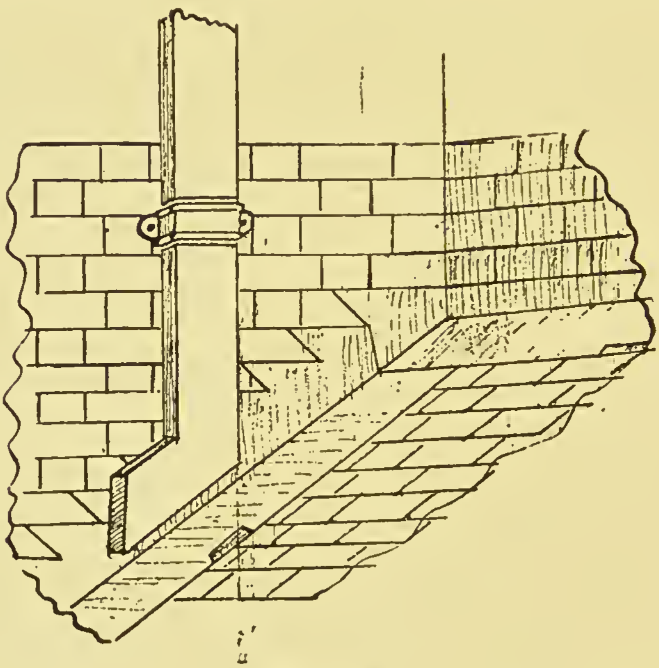

Fig. 42 b.

caused a great amount of damage, owing to the large volume of water washing under the slates, especially where the roofs were not steep. But where a roof is very steep, and proper soakers or ordinary step-flashing are fixed, and, as an extra precaution, if a wider leaf is made on the flashing below the shoe, no great objection can be raised to a shoe like Fig. 42 b discharging on the roof. But the best plan to adopt is to form a gutter with the flashing, and have a roll at the outside edge to prevent the water running on the roof at all.

At some other time we will consider flashings and other outside roof work more in detail. Enough has been stated for the present to show the importance of proper flashings, especially where a larger quantity of water is thrown on a roof than it was originally intended to carry away.

If a shoe is required similar to that sketched at Fig. 42 B, first take the correct angle, or, as it is generally called, the bevel of the roof, and mark it on the bench, floor, or a smooth board, and set out the shoe its full size, showing the section of the pipe at the top, as shown in Fig. 43. The weight of the lead should not be less than 6 lbs. per foot; the size of the piece required can be obtained by measuring the length from the top of the pipe at 3 to the heel B, then to the end of the shoe at D. The width, of course, is the sides added together. The best plan to get the width correctly is to cut a narrow strip of lead and set out the angles on it and bend it to the section; it can then be used to mark out the lines for the angle on the lead. Dress out the lead and flap it smooth on a hard surface—be careful to get all marks and bruises out of it, or it will look very bad when it is made up. Plane up the two edges straight, and then if the seam is to be at one of the back angles, strike the three parallel lines, as shown at Fig. 44, to represent the angles 2, 3, and 4 in section. Now proceed to get the dimensions for making the elbow by taking the length from the top of the pipe at 2 to the angle A, and mark it off on the lines 1, 2, and 1′,

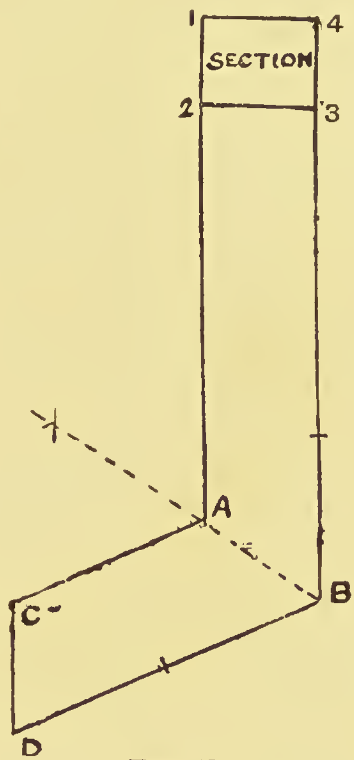

Fig. 43.

at points A′ A and A′, as shown in Fig. 44. Then take the length from the top of the pipe at 3 to the heel at B, and mark it off on the lines 3 and 4 at points B′ and B. Strike a line across the lead through the points B′ and B, as shown by the dotted line.

The points below this line can be marked by placing the leg of the compasses on the points where the dotted line crossed the angle lines, and marking off the same distance below the line as those above. Now draw lines to connect these points as shown. This is all that is really necessary to cut out a shoe. The lower end can be cut to the required angle with a saw, after the pipe is turned up. But perhaps it will be best to show the thing complete while we are about it, because sometimes a piece of lead will be used in that has a corner off, which would otherwise be thrown on one side, and a larger piece cut. This is one of the advantages of setting the lead out before it is cut to the required size.

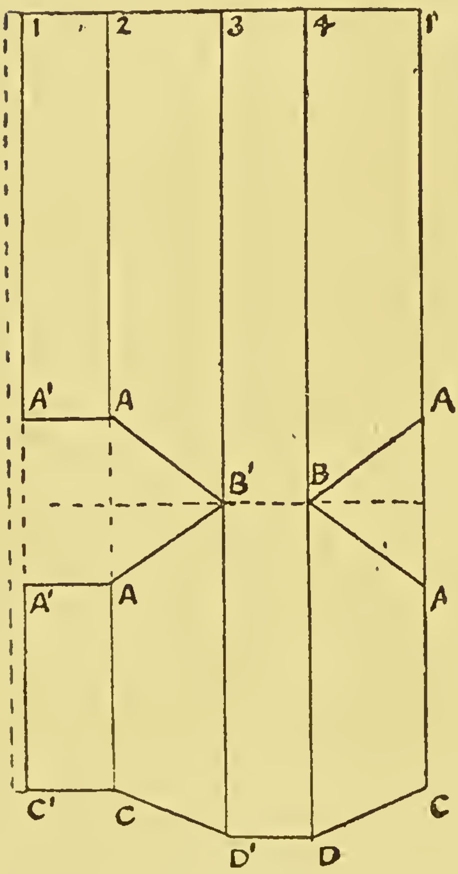

Fig. 44.

Now take the length from A to C, Fig. 43, and mark it off on the lines 1, 2, and 1′ from the points A′ A and A′, to the points C′ C and C′. Then take the length from the heel at B to D, and mark it off on the lines 3 and 4, from the

points B′ B to D′ D, connect these points as shown, and cut the lead out to the lines given.

Before turning the lead up to form the pipe, it gives a neat appearance if the angles are turned up sharp by scoring them inside with a shavehook. If this is done carefully with a round-pointed shavehook, using a straightedge for a guide, and if not more than one-third of the thickness is taken out of the lead, no harm will be done, as I explained in a previous chapter.

Where an objection is raised to scoring the angles on account of weakening them, it is easily remedied by only scoring the front angles and then shaving them, and floating in a small seam of fine solder with a copper-bit, or, what is better still, a gas blow-pipe.

The back angle can then be turned without being scored by using a mandrel; but if the shoe is a very short one, the back angle can be scored and soldered from either end; then no mandrel will be required. This is an object when there is only one shoe to be made; it does not pay to make a mandrel especially for it.

The seam at the back should now be soldered either by wiping it, or else by floating a good seam with a copper-bit, as shown at Fig. 31. The latter is the most convenient plan, and is quite good enough for this kind of job. The neatest way to solder the joint at the elbow is to bevel the two edges with a rasp about a quarter of an inch back. Bring them together, and tack them with the bit in two or three places, and after burring the two edges together, to prevent the solder running through, solder it flush with the copper-bit, and clean it off level with a rasp file and glass-paper. If the shoe is made of zinc the angles should be scored similar to the lead; they will then turn up straight and clean, and can be soldered in the same manner. But when the zinc is cut out a margin should be left on one side,

as shown by the dotted line (Fig. 44), so that it can be turned round to the back and lap the other edge. This will make a more substantial seam than it would if the edges only just met. Although I have mentioned zinc, it cannot be recommended for such jobs, either for its appearance or durability, especially when iron pipes have to be matched.

Before the shoe is finished, it will be necessary to make an astragal or moulded socket to match as near as possible the sockets on the iron pipes. It looks a very mean affair to fix a shoe or bend without an astragal to match. If they are the simple form of socket that is generally cast on square iron pipes, they are very nearly matched by the process described at Fig. 36, and as this style of astragal is easily made, it is therefore the most suitable to the job we are describing, because when only one shoe has to be made it is too expensive to make moulds or blocks for that one only.

When a length of moulding is made, as already described, the edges should be rasped or planed nice and straight, and the mitres cut in a mitre-box, similar to those used by carpenters to cut the mitres of skirting mouldings. But if a box of this kind cannot be obtained, it is not much trouble to rasp them up to the required angle. When they are fitted properly, solder the angles inside strongly with the copper-bit, clean off the mitres outside with a file; now place the astragal on the end of the pipe, and cut the sides flush with the back of the pipe. The back of the socket and the ears should be formed out of one piece, as shown at Fig. 45. This should be made of thick sheet lead about 12 or 14 lbs. to the foot, or if sheet lead is not to hand cut open a piece of heavy pipe. After dressing it out and cutting it to the required shape, either with plain or ornamental ears, bore the holes for the nails with a large gimlet, and then solder it to the astragal and pipe in the

following manner—of course it can be all done with the copper-bit, but the strongest and neatest way is to wipe the back in, as shown at Fig. 45. To do it in this way, soil the end of the pipe inside and out about three inches long, and shave it about an inch wide from the edge all round the outside, and about half an inch on the inside of the back, soil the socket inside, and shave the lower edge inside an inch wide.

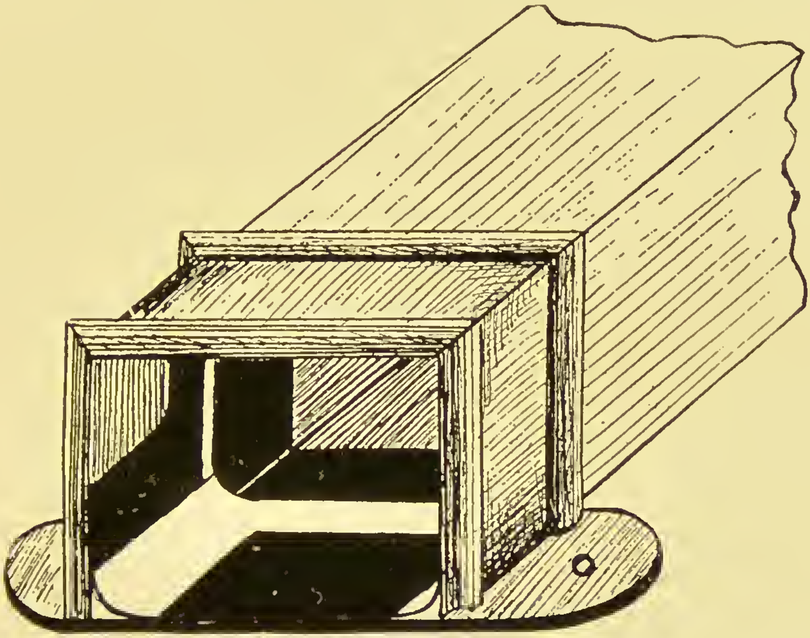

FIG. 45.

The back edges of the socket that are to be soldered to the piece forming the ears should be soiled and shaved in the same manner. Soil the thick back piece all over, and shave it where it joins the astragal about an inch wide, also at the bottom edge where the pipe will lap it about an inch and a half wide. Now place the back piece on the bench in a convenient position, and lay the end of the pipe on it about an inch; slip the astragal over the end of the pipe, so that the pipe enters about an inch; place something on the

top to keep it down when it is being soldered, and nail some blocks close to the side of the socket to keep the sides steady; wipe the angles in the ordinary manner, but sweat the back seam well with an iron. If this is carefully done nearly all the solder can be wiped off, because if it is well sweated the solder will flow between the two shaved surfaces and make a good joint without any solder on top.

Now stand the socket upright and solder the sides and front of the socket to the pipe by sweating some fine solder in between the two shaved surfaces with a pointed copper-bit or gas blow-pipe—the blow-pipe makes the cleanest and strongest job. This seam forms a shoulder inside the socket for the spigot end of the pipe to rest on. Another plan is to open the end of the pipe to form the socket independent of the astragal. When this style is adopted care must be taken not to score the angles right up to the end which has to be opened, or some difficulty will be experienced through the angles splitting when the socket is being formed. The ears in this case are cut out separately. The front angles of the astragal should be soldered together, as before described, and tacked on the socket; the back edges should then be soldered on with the same wiping as the ears. If this is carefully done it will not be necessary to solder all round the front edges of the astragal, but only tack it with the copper-bit at the angles; this will then be quite strong enough for all ordinary purposes. Where a socket is required only as a finish and not to match any other, a very simple way is to cut a piece of half-inch pipe down the middle and solder it round the socket top and bottom, so that it forms two round nosings or beads. Although this is rather a plain way of doing it, it certainly looks better than nothing at all.

# CHAPTER X.

## CURVED AND ANGLE BENDS.

AS an illustration of square pipe bends, made in the curved form, with the front, sides, and back cut out in separate pieces, the front angles wiped and the back soldered with a floated copper-bit seam, I have given a sketch at Fig. 46 of a pair of set-offs and a breeches or Y piece combined.

Some years ago several of these were made for a large railway station in London. They were required to convey the rain-water from two gutter cesspools, one each side of a stone corbel, on which rested the ends of the arched iron girders that carried the station roof. The lower end of the breeches piece fitted into the socket of an iron,—square, or, more correctly, rectangular—rain-water pipe.

They were made in three parts, the two upper set-offs being made separately to slip into the arms of the breeches piece. It was necessary to make them in parts to render them more convenient to make up, and also for fixing. They were, of course, rather expensive, as any practical man can see at a glance. But as there were several others of different patterns to make, it was thought that it would be more economical to make them of sheet lead than to go to the expense of making patterns, a great number of which would be required if they were to be made of cast iron, not to mention the delay that is generally caused when special castings are wanted.

Another advantage gained by making them of lead is,

if an alteration is made, the lead bends can be altered with but little difficulty, whereas, in the case of iron, either the structure has to be altered to suit the iron bends, or set-offs,

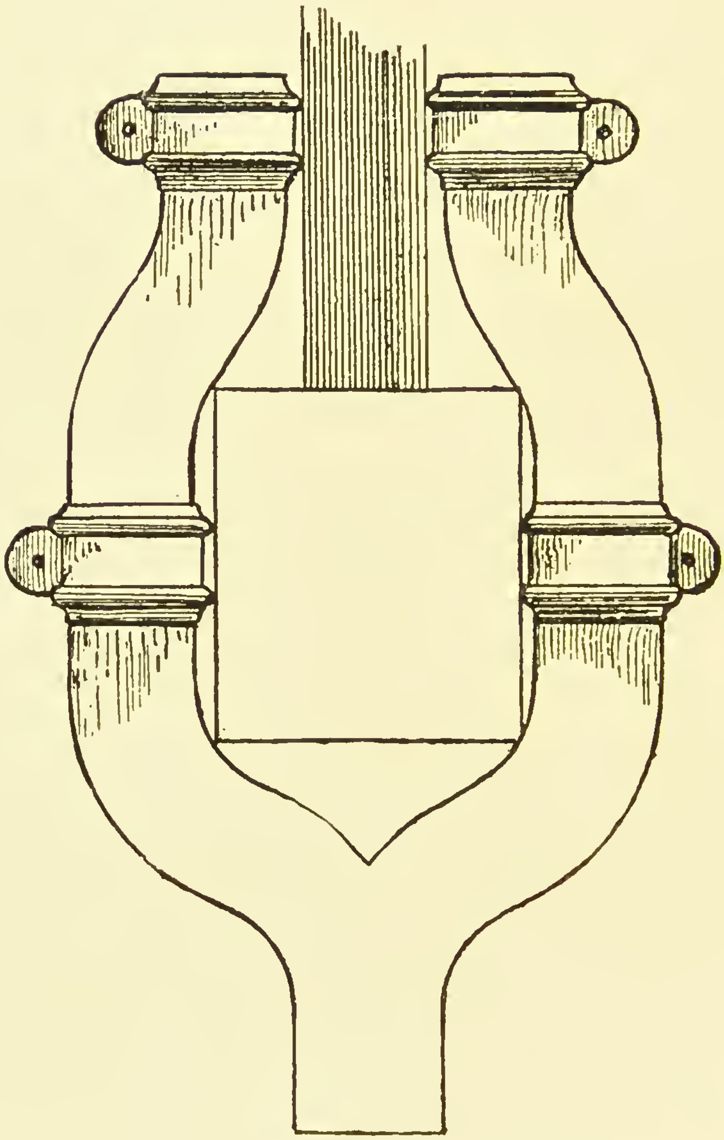

Fig. 46.

or whatever they may be, or else it has to be thrown on one side as useless. This, of course, would not be the case with ordinary shoes and set-offs, but it often happens when special

castings are made. With regard to the shape of the bends, many plumbers to do a job of this kind would make up the

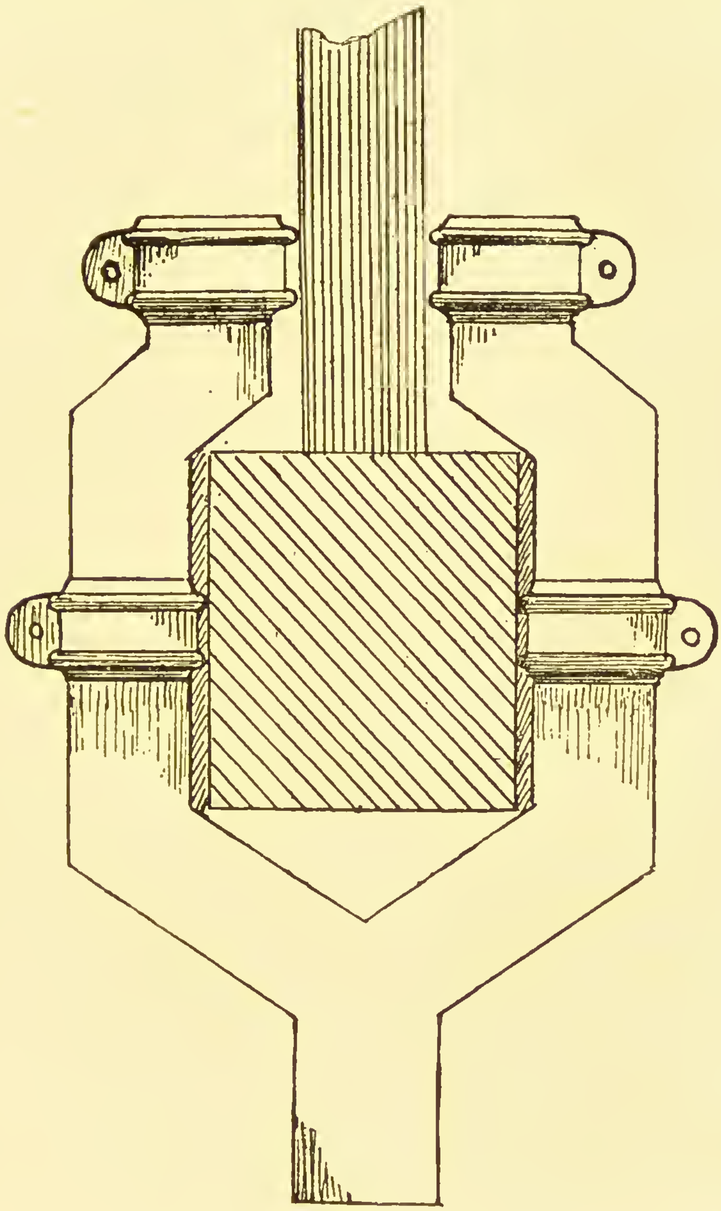

Fig. 47.

square pipe in lengths first, and then cut them up in sections to form elbows, similar to those shown at Fig. 47. This plan may in some instances be a very suitable way of doing

this kind of work, and probably would be more convenient than the plan shown at Fig. 46. But when such jobs are required for fixing on the fronts of buildings, where they are seen in connection with architectural designs, the curved style of bend looks more ornamental and neater than elbows, and very often makes up for jobs that would otherwise look awkward and unsightly. It is not always left to the plumber to design the style and shape of these bends, generally the architect gives a drawing or a rough sketch according to his ideas. But in any case the plumber has to set it out to the full size. This should be done carefully, as a good start in this respect saves a large amount of trouble in fitting and cutting later on.

If the bends are required in the form of elbows like Fig. 47, first make a full-sized drawing of the elevation on a large board or sheet of paper, care being taken to get the lines for the mitred elbow joints to the correct angles and corresponding to each other. Then if the soldering is to be done wholly with the copper-bit, the pipe should be made up in lengths by one of the means already described in former chapters. The mitres should be cut with a fine saw to the lines on the working drawing. When cutting the mitres for the two set-offs, after the first piece is cut, the bevelled end should either be used for the next elbow or else for the corresponding elbow on the other side. They will be found to work into each elbow without any waste pieces, as is the case when only one elbow is required.

After fitting the ends together by rasping with a fine rasp, so that the edges fit exactly, the best way to solder them is to bevel off the inside edges about an eighth of an inch, and well sweat them together from the inside. When the pipe is short and the elbows are near the end, there is no difficulty in soldering them this way. It makes a much neater job than soldering them outside, and does not require

any cleaning off. But if the elbows are too far from the end to reach with the copper-bit, the only alternative is to solder them outside and clean the seam off flush, that is, as far as soldering is concerned. But to plumbers who are used to lead-burning it would be an easy matter to burn the seams. They could then be cleaned off and made invisible.

This method involves a very large amount of time and labour to make them look clean and smooth. In fact, bends on square pipes made in this way take more time than some people are aware of, owing to the trouble of fitting so many edges, and cleaning off the superfluous solder; although I have known some persons who think it the most economical manner of doing such jobs. In my opinion, cleaning off solder should be avoided by plumbers as much as possible, for several reasons. Of course it is absolutely necessary in many cases, but where it is practical, the best plan is to arrange the work so that when the soldering is done it should remain as it is left by the wiping cloth or copper-bit. It always seems to me so unworkmanlike to have to clean off soldering if it can possibly be arranged in any other way. There is no doubt it also encourages carelessness in the art of soldering. As soldering is one of the most important parts of plumbers' work, and a branch in which most plumbers take the greatest pride, and is undoubtedly worthy of the first consideration in all parts of the trade, everything should be done to encourage the most skilful, and at the same time the most efficient styles of soldering possible. These, among others, are some of the principal reasons why bends made in the form of Fig. 46 are much to be preferred to those made in the form of elbows from lengths of pipe and soldered on the fronts.

They can, of course, be wiped flush outside, but this way cannot be recommended, because a sinking would be required to wipe them flush in a proper manner, thereby reducing

the bore of the pipe at the elbows, which is objectionable; and then the joints would always be noticeable, whether the pipe is painted or not.

Supposing the bends are required in the form of elbows, as shown at Fig. 47, it would be more advantageous to make them as those shown at Fig. 46. The only disadvantage is the consequent waste of material incurred in cutting the lead out, owing to the inconvenient shapes of the front and back pieces ; but this is more than compensated for in the time saved and other advantages, not to mention the tinkering avoided.

If a bend or set of bends are required similar to Fig. 46, a very good plan is to set out the bends full size on a large piece of paper. Then the different parts can be cut into separate pieces. These paper patterns can then be pasted on a piece of lead, and the lead cut to them exactly. But if there are several to make, it is much the better plan to paste the paper patterns on thin pine boards, and get a carpenter to cut them out to form templates, to mark the lead out by. Of course, if the bends are small, they can be set out on the lead at once without any further trouble.

The manner in which the set of bends shown at Fig. 46 were made was as follows :—

After setting out the bends full size, wooden templates were made to mark out the lead by. The front and back pieces of each bend were then tacked together at the edges with the copper-bit. The edges were then cleaned up with fine rasps and files. The reason why the two pieces were tacked together was to ensure the edges being perfectly parallel, because it very often happens if they are rasped up separately one is rasped more than the other, and when they are made up the angles look irregular, and have a very bad effect when they are fixed in their positions. After the lead is properly prepared, the inside of the front piece is

soiled all over, and the edges shaved about an inch wide; This is laid on a perfectly level block. (It is very important that this block should be very smooth and level, as on it depends the appearance of the work when it is finished. If the block is not as it should be, no amount of cleaning up the angles will make the work look neat and clean.) The ends of the front were nailed down with copper tacks, to keep it steady when the sides were being fitted.

The edges of the sides were planed up with an iron-faced

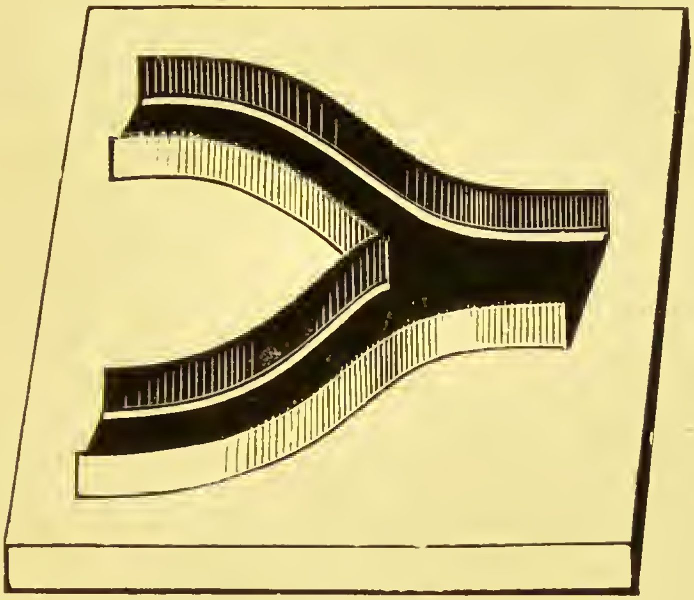

FIG. 48.

plane, and made perfectly straight. The edges joining the front were soiled and shaved about an inch and an eighth wide, and bent close to the piece, lying on the block as shown in sketch Fig. 48. A strip of lead is placed round the outside edge, and some large clout nails driven in the block tight up to the strips. This holds the sides firmly while the soldering is being done; the strip of lead prevents the nails marking the sides, as they would do if they were driven in close without the strip in between. After the

sides are fastened up tight, the point of the compasses, or some other sharp tool, should be drawn along in the angles

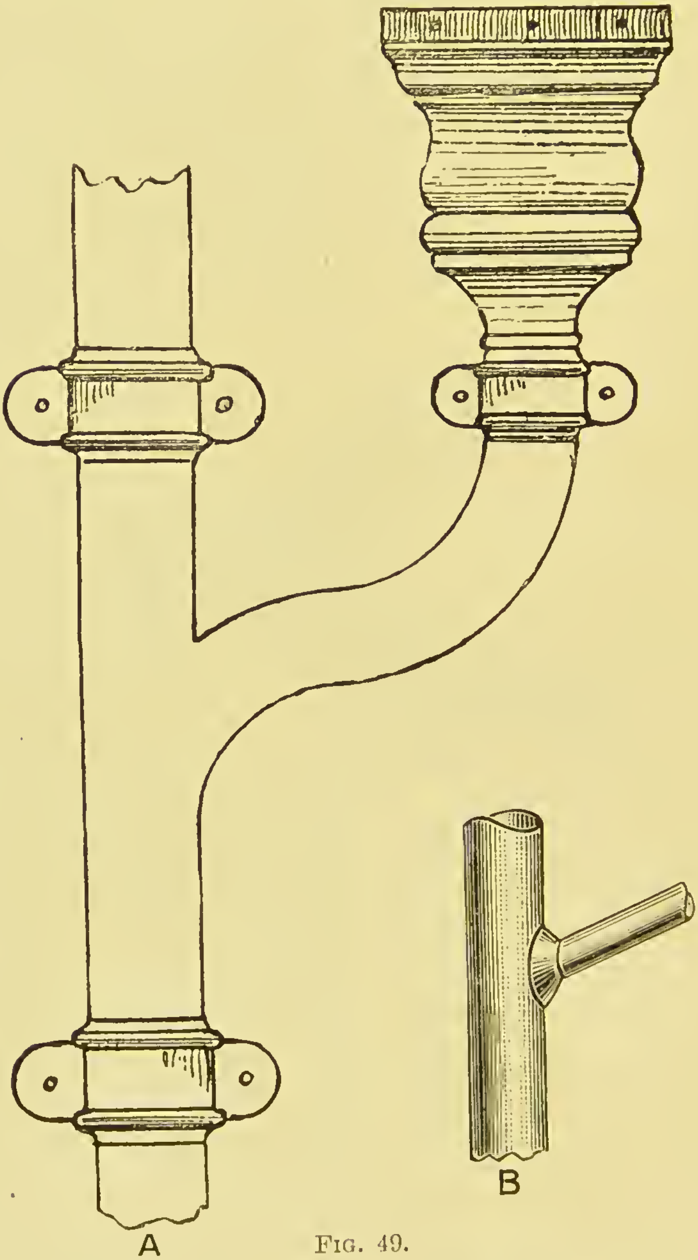


FIG. 49.

to burr the two edges together, and thus close any spaces where the solder can run through. They were wiped in the

ordinary manner with a small cloth, but rather light, because it is unnecessary to leave much solder on. A very small quantity of solder in an angle, if the lead is well tinned, makes a good strong joint.

The backs were then soiled, and shaved about a quarter of an inch from the edges and champered a little to make a sinking for the fine soldering. The back edges of the sides were soiled about an inch wide on the outside, and shaved on the edge, and down the inside about an eighth of an inch. The backs were then fitted in flush with the edges of the sides, and lightly tacked with the bit in several places. After the two edges were burred together a good clean steam was floated with a large hatchet bit and fine solder.

All the cleaning off that is necessary is a fine file drawn along the front angles where the two edges meet.

The astragals were made, as already described, by working a piece of sheet lead on a piece of oak moulding, made to the same pattern as the socket on the iron pipes. These were worked in pieces long enough to make the three pieces for one socket. They were then cut in a mitre box, and soldered inside. The ears and back were in one piece of lead, and soldered in the same manner as described at Fig. 45 in the previous chapter.

Fig. 49 A is another example of a job in square lead pipe. It represents a junction in a square iron rain-water pipe, for conveying the water from a lower roof. There are many instances where this kind of job is required, but it must be admitted it is not very often done in this way—such, for instance, as waste from baths and lavatories, and many other fittings where special waste pipes are not provided.

Of course it is much better to fix separate waste pipes, but as they incur extra expense they are therefore very often taken into rain-water pipes. Generally when a junction is wanted in an iron stack pipe, a hole is made in the side of

the pipe, the end of the waste pipe is then pushed in, and a piece of putty or red lead is stopped round it to form a joint, as shown at B.

This is a tinkering plan at the best, and very seldom makes a permanent job, especially if hot water is discharged down the pipe, because the expansion and contraction soon break the joint. Cases frequently occur where the end of the waste pipe has stopped up the rain-water pipe by being pushed in too far, and obstructed the way of the leaves and other matters passing down the pipe. This can be made better by soldering a flange on the waste pipe near the end, but it makes a botching job under any circumstances. An arrangement like Fig. 49 is very useful where there are several waste pipes to be conveyed into a down pipe; they can be discharged into the head, and thereby make one connection with the down pipe answer for the whole of them, at the same time making a more respectable job, both from a practical and a sanitary point of view.

Not that an open head is the most desirable arrangement for receiving waste pipes. Where they are situated under bedroom windows the smell arising from them is often very objectionable, and in frosty weather the waste pipes are more likely to be clogged with ice, or the head to be stopped by the same means, whereas continuous waste pipes properly ventilated at their upper ends are more satisfactory.

# CHAPTER XI.

## SQUARE PIPE FIXINGS.

IN preparing the fixings for square or other shape lead pipes, especially those made to match iron pipes, plumbers have very often made some serious mistakes

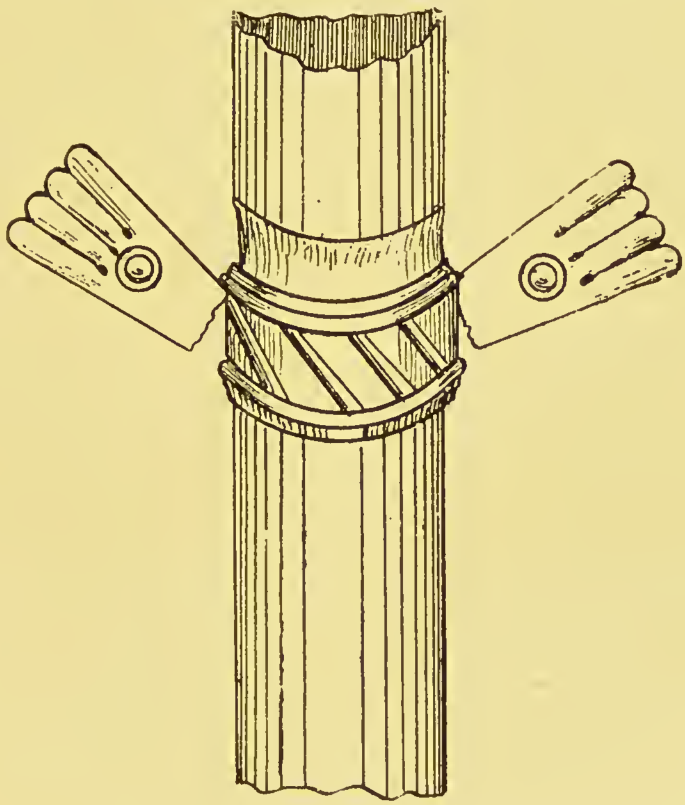

FIG. 50.

through having copied the pattern too exactly without considering the nature of the metal they were using. There are several kinds of fixings used for iron pipes which, when

adopted for that purpose alone, make a good substantial job; but in the case of lead pipes the style of fixing may be, and frequently is, entirely unsuitable, because lead is not only a much heavier metal but very malleable, consequently a firmer kind of fixing is required. This is especially the case with ornamental pipes; they are generally heavier than those made to a plain pattern, and in most instances have large long ears with the nail-holes far from the centre of the pipe, therefore the long leverage is too great for a metal like lead to withstand, without some additional means being used to support the weight. As a case in point, a few years ago I saw a good illustration of faulty fixing which occurred through too nearly matching the iron rain-water pipes. At a large mansion at the West End of London the rain-water pipes were very heavy cast iron, with flat backs and half-circular fronts. They were fixed by means of a loose band and ears cast in one piece, which fitted round the socket between the two mouldings, and were fastened to the walls with one nail in each ear, as shown in sketch Fig. 50.

The soil pipes were made of lead to the same size and pattern as the rain-water pipes. Each length weighed nearly a hundredweight and had to depend on its own fixing, as the joints were only socketed and stopped and not soldered. The result was, owing to the nails being so far away from the socket, the leverage was too great for such slight ears to withstand; consequently nearly every length had slipped down from two to four inches, breaking every joint, and on taking the pipes down, it was found that all the ears were either half or entirely broken off, as shown in sketch Fig. 50. In several cases pieces were torn out of the back of the socket; in fact, it was a matter of surprise that the whole stacks did not fall down with a crash, for there was very little to keep them in their position. These

soil pipes were evidently fixed at a time when ventilation and disconnection were not considered necessary, therefore

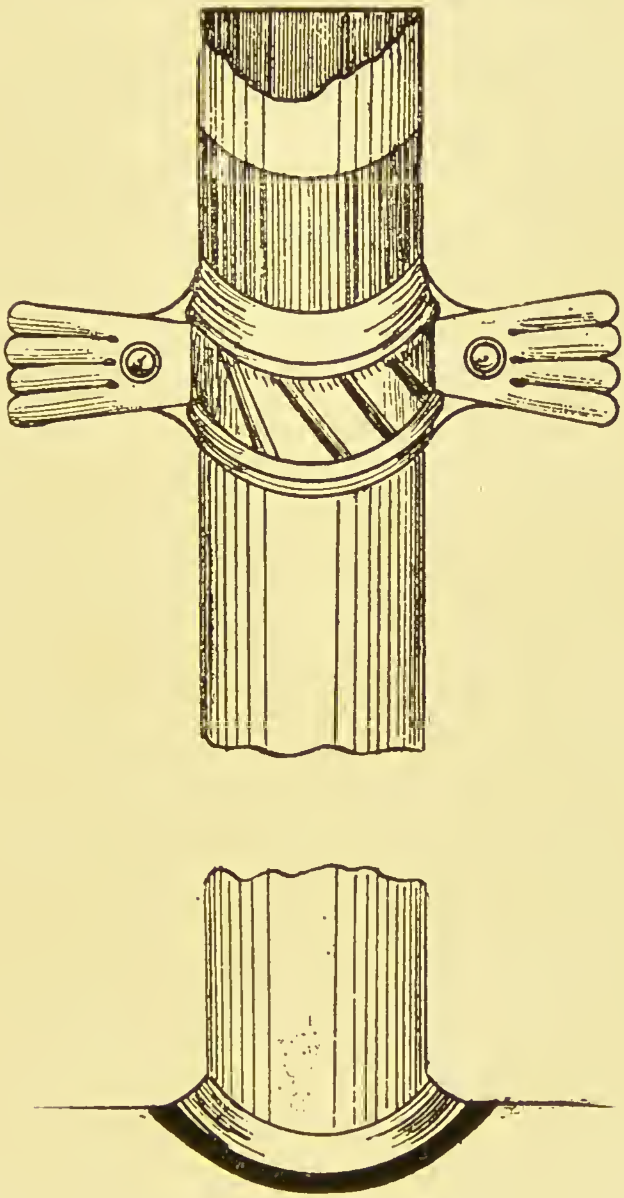

FIG. 51.

in their unventilated condition they may have been the source of much danger to health, because the gases

escaping from the joints could easily pass into the bedroom windows above and around them, which in some cases were only a few feet away; and what made it more serious was the confined position they were placed in, which was a small courtyard, or what would be more correctly described as a shaft arranged in the centre of the house for the purpose of supplying light and ventilation to the several apartments adjoining the said shaft. It is possible to go on to almost any length describing the unsanitary condition of this and several other grand West End mansions; but as sanitation is not the subject in hand at present, we will reserve further remarks on this subject for a future occasion. It will be enough for our present purpose to say we were not allowed to do as we should have liked in this matter, that is, to clear the whole lot out and fix new and better arranged soil pipes. But the orders were to do the best we could with the old ones. All the lengths were therefore taken down and the broken ears cleaned off the sockets; the ears were then made shorter so that the nails were placed nearer to the pipe. In soldering on the ears, the solder was made to form a bracket at the top and bottom of the ear, as shown in sketch Fig. 51. In addition to this every socket was cleaned and tinned, from the top edge to the first moulding; the spigot ends were also tinned about an inch and a half from where the top of the socket of the next lower length comes to when it is slipped into the socket. All the joints were then wiped as well as socketed, as shown at Fig. 51.

After being fixed with strong nails through the ears, and a flange wiped on the foot of the bottom length (as shown in sketch) for a foundation, it made a good, sound, and substantial job. Of course, a ventilating pipe was continued up above the roof to complete the work in a proper manner. Now, in case of lead rain-water pipes it is not only unnecessary but it is much better not to solder the joints,

because where it is practicable lead pipes should always be allowed to contract and expand according to the temperature they are subjected to. Consequently when heavy lengths of pipe have only two ears, which are generally not very strong, some additional fixing is absolutely necessary if a substantial job is required.

A very old-fashioned style is, when cutting out the lead for the square or other kinds of pipe to arrange for a tongue, or as some would term it, a tack at the top and back of the socket, as shown in sketch Fig. 52. This is either turned into a joint of the brickwork and fastened with wedges, or else two or three wall hooks are driven through it in the ordinary way of fixing tacks. When

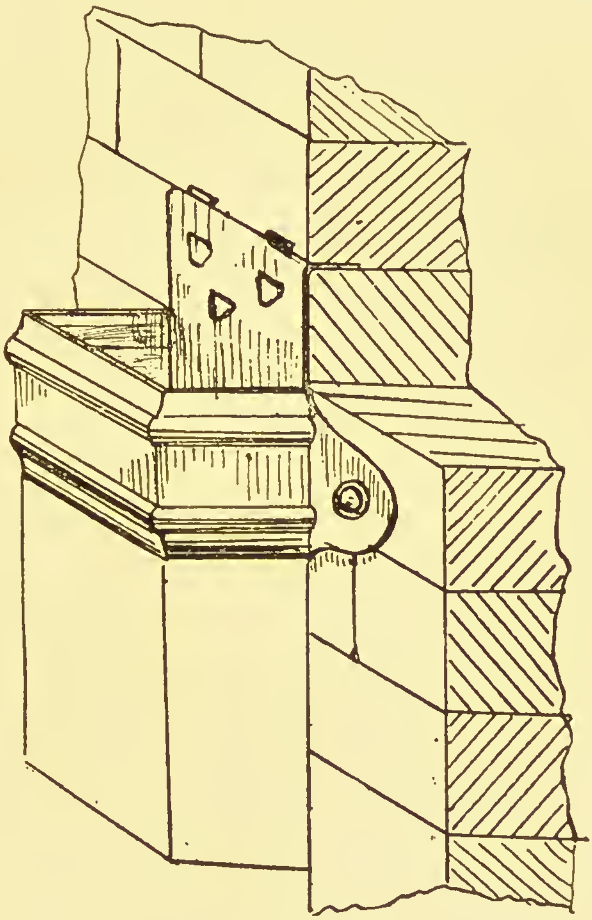

FIG. 52.

the sockets are cast, this tongue can be made on the socket at the same time. If the astragals are formed out of sheet lead, as already described, the tongue can be made with the ears in one piece, as shown at Fig. 52. Another plan is to form the socket and the tongue for fixing on the length of

pipe before the astragal is fixed on. There is much to be said in favour of the latter plan, especially if the lead pipes are very heavy, such as eight or nine pounds to the foot; because as the fixing is entirely independent of the ears, they can be made as light and ornamental as desired. Extreme lightness in appearance should not, in my opinion, be carried out where lead pipes are fixed by themselves, but only in cases where they are to match iron pipes, such, for instance, as the case described above; because, from an architectural point of view, everything should look as strong as it really is, providing it is not overdone by waste of materials and clumsiness.

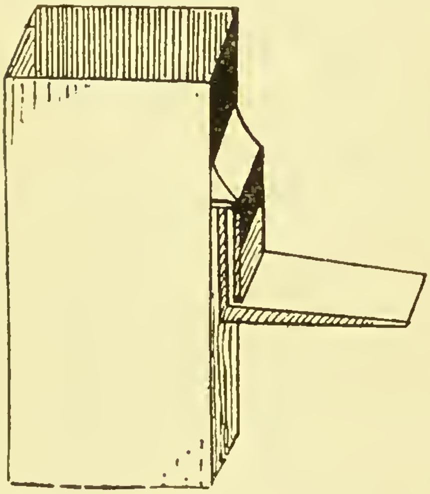

Fig. 53.

For my own part, I think it would be much better to fix lead pipes in shorter lengths than they are usually, or else they should have additional astragals and ears instead of secret fixings. There seems to me something so very objectionable about anything secret in the fixing or the arrangement of work of any kind. Of course there are some kinds of work which require special treatment, and cases where one cannot do as he likes; therefore we have to be ruled either by persons or circumstances, and have to arrange our work accordingly.

Another very good style for secret fixing is to solder a thick lead clip or tack about half way down the length at the back, leaving a space of about a quarter of an inch between the tack and the pipe. This is made to fit on an iron, brass, or copper hook, driven in the wall behind the pipes, a section of which is shown at Fig. 53. It need

hardly be said that stacks of pipe with secret fixings of this kind must of necessity be started at the bottom, otherwise it would be rather an awkward job. Although it might be done on a flat wall, the length could be socketed at the top first and then slipped on to the hooks sideways. It would be rather a troublesome job, but could be got over; but if the pipes were fixed in a chase, as they sometimes are, they can only be started from the bottom. I do not see how there can be any serious objection to a pair of plain tacks soldered on each side of the length, either about the centre of the length or near the bottom. This would not look unsightly on flat walls, but where the pipe is fixed in a narrow chase it would be a difficult matter to fix tacks of this kind, although this is generally where additional fixings are most required, because, as is very often the case, the chase is only just wide enough to take the pipe, consequently the ears have to be arranged so that they can be fixed on the front of the wall; and if the nails are to be driven in, so that they do not burst the angle off the brick-work, they have to be kept so far apart and from the centre of the pipe, that the long leverage causes the pipe to break away from the ears. Therefore in cases of this kind it is very necessary to adopt some such plan as shown at Fig. 52 to carry the weight of the lengths.

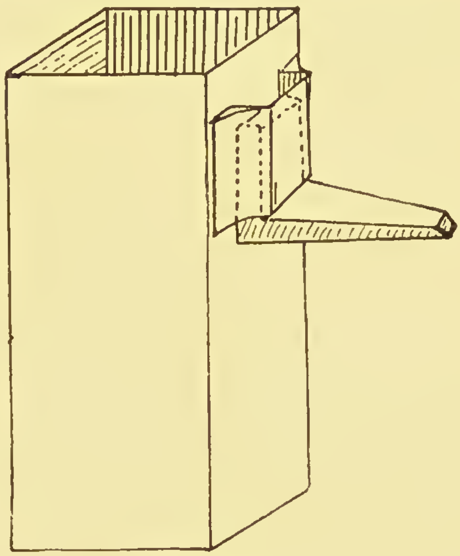

FIG. 54.

There is no doubt the plan shown at Fig. 52 is much to be preferred before any other, as it holds the weight of the

lengths and at the same time leaves them free to expand and contract. This is very important where the pipes are exposed to the sun's heat, and more especially where hot-water waste pipes are connected with them, such as bath or lavatory waste pipes. There is another kind of secret fixing which is used principally in the North of England. It consists of an eye, or what may be termed a socket formed of a piece of sheet copper about four inches square. This is bent to the form shown at Fig. 54, and soldered to the back of the pipe by a copper-bit seam. Generally, the edge of the socket piece is placed close to the back at a right angle and soldered in the angle; but if they are to be soldered on with the copper-bit, it is a much better plan to turn a flange on the back edges about half an inch wide. The side of the flange touching the back of the pipe should be tinned and then well sweated to the back of the pipe. But the best plan, in my opinion, is to wipe them on as shown at Fig. 54. This makes a much stronger job and more reliable than the other style. This eye is then slipped on to a hook or staple driven into the wall about four inches, as shown in the sketch. If the pipes are to be fixed close to the wall, it is necessary, in this case, to cut the wall away sufficiently to allow the hook and eye to go in flush. There are instances where it is not necessary to let them into the wall, because sometimes architects will have the rain-water and other pipes kept away from the face of the walls, to prevent the water saturating the walls in case of overflow and leakage. In such cases the hook and eye is a very convenient way to fix rain-water pipes, but there should not be less than two hooks to a length of pipe, which is generally about six feet long.

# CHAPTER XII.

## JOINT-WIPING.

JOINT-WIPING forms a large and important branch in the art and craft of plumbing. It is undoubtedly that part of the work which requires more care, skill, and continual practice than most of the other branches, and on it depends, to a very large extent, the success or failure of most particular jobs, especially in sanitary plumbing. How many serious cases of disease have been traced to bad jointing, through the inability or carelessness of the workman! I was going to write "plumber," but a man is not worthy of the name if he cannot make a sound reliable joint, even if it be in an awkward place, or under adverse circumstances. Of course it is not expected that a joint can, under all conditions, be as perfectly symmetrical and well proportioned as if it had been turned in a lathe. The best of plumbers have to leave joints that they would be ashamed of, as far as the appearance is concerned, if they were made on the bench or in some other convenient place. When circumstances are not favourable, sound work has to be accepted as good work, and beauty must be sacrificed for efficiency. Unfortunately there are too many who seem to always think that sound work is good work, and therefore never try to make their work look as creditable to themselves as they should do, and thus become artists in lead and solder. The only artistic merit some seem to attain to, is to spangle themselves with the silvery metal, and carry it about on their clothes as a trade mark. The whims and fancies and

different styles of joint-wiping are so numerous, that one could go to any length describing the many eccentricities and peculiarities that are displayed in this particular branch of the trade. Of course every one has his own peculiar ideas in most matters, and no person does a thing exactly like another; but to my mind these idiosyncrasies seem to be more apparent in the matter of joint-wiping than in any other part of the work.

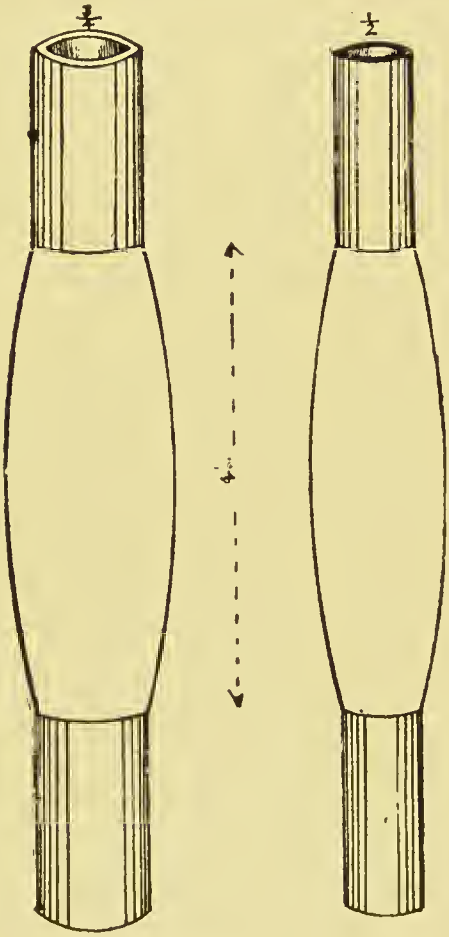

Fig. 55.

After a young man has been in the trade for a short time, his one great ambition is to wipe a joint. He seems to think that if he can only manage to get a small portion of solder to adhere to a piece of pipe, and then so manipulate it as to induce it to take the form of an egg or a turnip, as the case may be, he has done something to be proud of, and soon begins to think he ought to be a full-blown plumber. This acquirement with a large number now is their standard of efficiency. If the abilities of certain plumbers are being discussed, the question is asked: What sort of a joint can he wipe? Does he wipe all kinds, underhand, upright, or branch, with equal ease? or is he only good at upright joints and nowhere at underhand work? Can he make joints without an iron? or

will he insist on having an iron to nearly all his joints, irrespective of his mate's unwillingness to run down four or five flights of stairs and up again to bring him one? Another question with regard to joints is the proper lengths to make them. Some like long joints, like Fig. 55; others prefer short ones, as shown at Fig. 56. The advocates of long joints say that short joints are ugly, and are not proportionate. They are often compared to turnips, and other things not quite so regular in shape. Those who are in favour of short joints say the long ones are not so sound, that they will not stand a great pressure, and are liable to sweat. Some call them "long dirty tinned ends," and regard them as the result of an eccentric fancy. Certainly the joints shown at Fig. 55 look as if the man who made them does his joint-wiping by the yard. Just imagine—those of my readers who have not seen one—a half-inch joint four inches long!

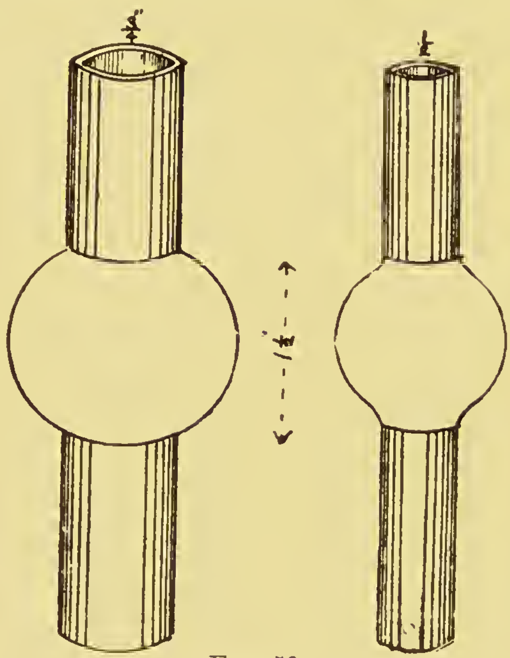

FIG. 56.

I have seen several, and know men who make them nearly that length now. It is, of course, ridiculous to make joints such enormous lengths, when a joint made more in proportion to the diameter of the pipe would not only be much stronger, but would look far neater, and generally require less solder. Then there is the question of wiping-cloths, or, as some call them, solder-cloths. A large number of plumbers like a very thick cloth for wiping joints, but, on

the other hand, as many, or perhaps more, say they cannot wipe joints with thick cloths. Many men who are used to thick cloths and can wipe joints as easy as possible, are quite beaten if they try to use thin cloths. The difference in the thickness of cloths is very great in some cases. I have known some to use cloths which have consisted of twelve thicknesses of moleskin—or what some term fustian—for making underhand joints on one-inch pipe. I have also known some plumbers to make joints with cloths only having five thicknesses of the same kind of material. Very thin cloths are not suitable for making joints a nice shape. When a man gets used to a reasonably thick cloth he can make joints far better and easier than if he used thin ones. Generally, plumbers who use thin cloths make joints very short and lumpy, and bare at the ends, so that the shaving is shown about an eighth to three-eighths from the ends, as shown at Fig. 57. But when thicker cloths are used it is much easier to make joints more like the shape shown at Fig. 58. This is very important in all joint-wiping, because wherever the shaving is left bare, the pipe is weaker here than any other part, whereas, if a joint is properly made, this part of it should be the strongest. In a large number of instances, when a pipe is subject to much expansion and contraction, it will break at this weak point very soon after it is fixed. It

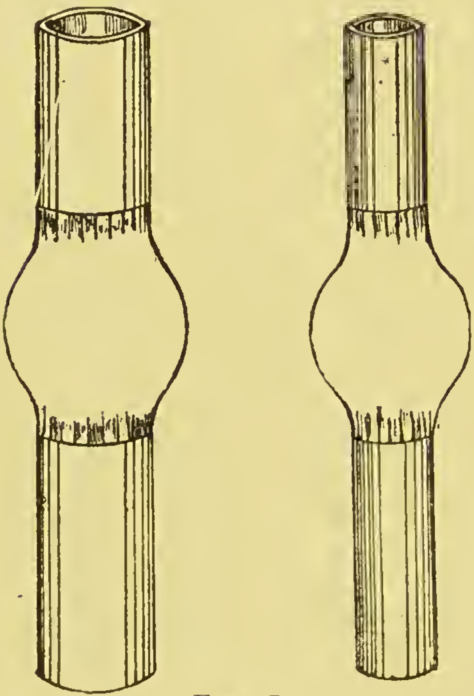

Fig. 57.

would be difficult to say generally what would be a proper thickness for cloths, excepting that they should be in proportion to the width and length. Cloths for large joints should be much thicker than those used for small ones, because the larger the cloth is, the more difficult it is to keep it in the shape required for wiping the joint. For instance, if a cloth used for making a four-inch underhand joint were made of only about six thicknesses of moleskin, it would be no more—or at least but little more—use than one generally used for three-quarter or one-inch joints; because when a small amount of solder falls on it, the cloth would bend down and let the solder fall, so that the solder would not remain in the cloth except that caught in the middle, where the hand is under it. Consequently, there is much difficulty in getting up the great heat necessary to make a large underhand joint. Then supposing it were possible to get up the heat sufficient to wipe the joint, it is useless to try to make the point as regular as would be the case if moderately thick cloth were used. The reason is, that when the cloth is hot it gives too much to the pressure of each finger, and therefore presses unequally on the surface of the joint, making it either bare at the edges and showing the tinning, or causing the body of the joint to be irregular

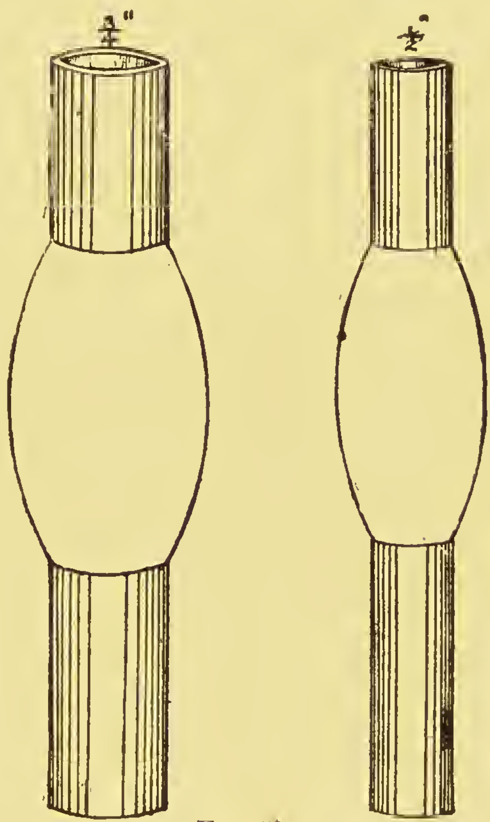

Fig. 58.

and bad in shape, more especially at the bottom where it is nearly bare, or else it looks as if it wanted not an immoderate dose of hammer and chipping knife.

My own opinion is, that a cloth should be just thick enough to prevent the impressions of the fingers having any influence on the body of the joint; but at the same time it should be thin enough to allow it to be bent the shape required without any great exertion. Of course, a cloth cannot be employed like a mould used by a plasterer to mould a cornice; if it could, it would not be so difficult, and require so much practice to make a joint as it does. Although there can be no doubt that suitable tools are indispensable to the workman, yet it must be remembered, by plumbers especially, that the cloth, however well made both in size and shape, will not make a joint without it is manipulated by an intelligent and experienced, if not a gifted, hand; in fact, it seems sometimes as if some plumbers cannot acquire the art of joint-wiping to any degree above mere botchers with the solder.

There are large numbers of plumbers who are splendid sheet lead workers. No job with a piece of lead comes amiss to them, but when they are required to wipe joints, it seems the more they try to get the metal to a proper shape, the more it will drop off, or else will get cold quicker.

First, they burn their hands, and then the pipe, or they make solid joints with a flat side to them to fit the wall. The result is, their tempers become ruffled, and the mate is blamed for not getting the metal hot enough; or else they complain about the solder being bad. It must have got some zinc in it, says the discomfited man of metal, otherwise the solder is too fine or too coarse. These do not comprise all the excuses by a long way; probably there is too much draught causing the solder to cool quickly, or the joint is in an awkward place; in fact, according to the talk

of many plumbers, all their joints and every other part of their work are awkward. They never get a handy job: all their work seems to be in the most inconvenient places possible. There is no doubt a great many have missed their most suitable avocations, for they should have been shoemakers, so that they could have all the work in a convenient place, and be able to sit down to do it. There is one remarkable thing about joint-wiping which I have often observed, that is, the way in which it reveals the different dispositions of men when they are wiping a joint. Take the case of a nervous man: in many cases one would think he was going to do something on which his life depended. He begins to tremble as soon as he takes the cloth in his hand, and when he pours the solder out of the ladle he appears to be afraid to let the metal fall for fear he should burn a hole in the pipe with the first drop. If a stranger is looking at him, he hardly knows what he is doing. I have known some who cannot make a joint if a stranger is looking on. This is not only the case with young beginners, but many men with long experience are always in this condition, when they are doing such an apparently simple thing as wiping a joint. A short-tempered man will soon fly into a passion if the least thing goes wrong when he is wiping a joint. If he should fail to make it the first heat, he begins to loose control over that unruly member, the tongue; the result is, he is in such a state of mind that he cannot get the metal to a proper shape the next heat; he tries another heat, and perhaps yet another, until he utterly fails to accomplish the task he undertook with such confidence. Finally he throws his hat to one end of the shop and his cloth after it, and kicks what should have been a joint over with his foot with disgust, and waits for cooler moments for a fresh start.

But men who can take things coolly, generally make the

best joint-wipers, they go about it in a methodical kind of way; if any little thing is not right they soon make it so, and wipe the joint with as much ease and apparently with as much pleasure as they eat their dinner. The question many will ask is: Why all this fuss about wiping a bulb of solder round the two ends of a pipe? why so much differences of opinion about the size and shape, the form and position? I think it would be very difficult to explain the reasons; all we know is that this difference does exist. And between the two extremes we will endeavour to find out the way to wipe joints to the best advantage.

But before doing so it may be interesting to give a few examples out of the many methods which have been introduced with the object of superseding the wiped joint. And also the way joints were made before the wiped joint came into general use.

## CHAPTER XIII.

### SUBSTITUTES FOR WIPED JOINTS.

SEVERAL kinds of apparatus have been invented with the object of superseding the plumber's wiped joints; in fact some have gone so far as to state in their advertisements that plumbers can be dispensed with altogether if a certain machine is used to joint the pipes; but up to the present time nothing seems to have been brought forward that will answer the purpose in any degree worthy of universal use. If machines for the purpose of making joints are used, they require skilled workmen, if not plumbers, to

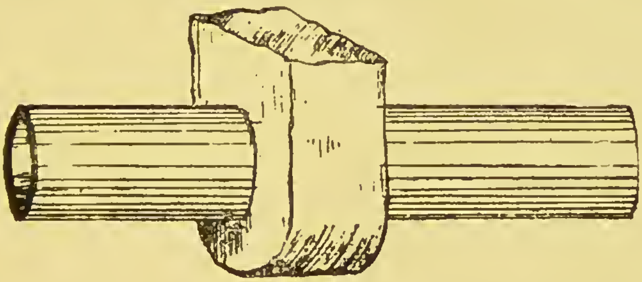

FIG. 59.

use them; consequently nothing is gained by their use, because a plumber can prepare and make a wiped joint quicker, and one that can be relied upon. But when machines of a complicated nature are made use of, they are generally more trouble than they are worth—are liable to get out of order, and become a nuisance. Another objection to these machines is the fact that, in many instances where the joints are not in a convenient position, it would be impossible to use one. It would be all very well perhaps

on a bench, or other equally convenient place, for certain joints ; but inasmuch as skill is required for joints in awkward places, machines would be entirely unnecessary, and a hindrance under more favourable circumstances.

In olden times other methods were adopted to join leaden pipes. One plan was to burn them, or they could be called melted together with molten lead instead of solder. Some years ago I saw a very good specimen of such a joint, a sketch of which I have given at Fig. 59. It was a joint on cast lead pipe, and was known to be some hundreds of years old. Of course it was a very clumsy affair when compared with a modern wiped joint; but there is no doubt it was considered good workmanship at the time it was

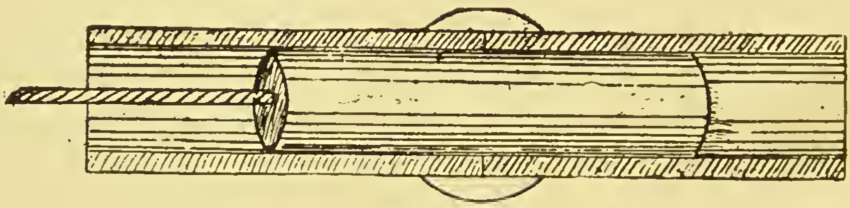

FIG. 60.

made. A short description of the way these joints were made will perhaps be interesting. In the first place, the two ends of the pipe are roughly prepared to butt together; an iron mandrel or sand core is inserted in the pipe, an equal distance each way from the joint. It is then embedded in sand, so that the pipe is covered with about an inch of sand. A hole is made in the sand round the intended joint, so as to leave a clear space round the pipe. On one side of the hole a groove is made in the sand, to enable the surplus lead to run away. When all is ready, and the lead hot, it is poured into the hole round the joint, and continued after the hole is full for a short time—the surplus running away down the groove in the sand—until the ends of the pipe are supposed to be thoroughly fused together. The core or

mandrel is then either drawn or driven out at one end or the other. The lead as it is cast is left on, I suppose, for extra strength; perhaps if it was to be fixed where it would be seen, it would be trimmed up and made more regular in shape.

No one would think of making joints in such a clumsy manner now, even where they are required without solder, as they often are in connection with chemical apparatus. A much neater joint can be made with a burning machine, concerning which we shall have something to write at another time. Generally, mandrels are unnecessary inside the pipe when the joints are being wiped, although they are sometimes used for special purposes.

The leaden pneumatic tubes laid for the General Post Office under ground in London have a heated gun-metal or iron mandrel inserted when the joint is made; but instead of the ends being prepared in the ordinary manner, they are simply butted end to end. The object is, undoubtedly, to make the inside of the pipe as smooth as possible, so that there should be no obstruction to the carriage containing the message that is blown through them. The mandrel is drawn out by means of a rope or chain, as each joint is made. A section of this kind of joint is shown at Fig. 60. Before wiped joints, or rather those finished with the cloth, came into general use, it was the practice to finish them with an iron: this is called over-casting. Fig. 61 is a sketch of an over-cast joint.

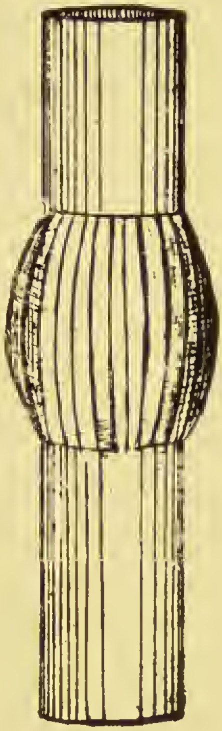

Fig. 61.

Until very recently it was supposed that over-cast joints were absolutely necessary in the case of pump suctions and

rising mains which were subject to high pressure. On nearly all old pump suctions the joints will be found over-cast. There is no doubt it was a good precaution to take, especially if the solder is rather coarse; but if a joint is properly prepared, and wiped with good solder, over-casting is not at all necessary. Generally, all over-cast joints are

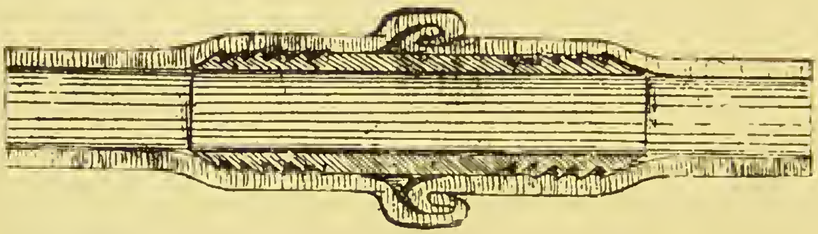

FIG. 62.

wiped in the first instance with a cloth, roughly; after which a hot iron is drawn backwards and forwards until the joint is covered with longitudinal facets. Much practice is required to make this kind of joint properly. Years ago it was considered very skilful to be able to make a good over-cast joint, and to keep the facets equal and regular in size.

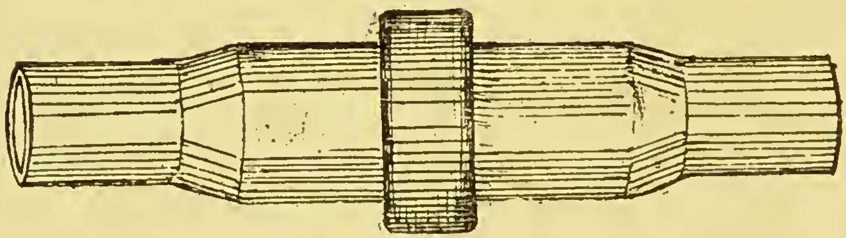

FIG. 63.

A rather novel kind of joint for lead pipes was invented a few years ago, with the object of doing away with both soldering and burning. Fig. 62 gives you an idea of the way in which this joint was made. First the ends of the pipe were opened to receive a brass ferrule, on the ends of which are turned grooves, with sharp edges, towards the centre, as shown in the sketch. Flanges were also made on

the ends of the pipe, these being brought together with the ferrule inside. It is then placed in a machine which presses the pipe tight on the ferrule, and at the same time welts the two flanges together, the joint, when finished, having the appearance of Fig. 63. I cannot give any account of the soundness and durability of these joints, not having had an opportunity of seeing them in actual use. I saw one after it had been made on about a foot of pipe, and examined it. The joint certainly looked very neat, and had the appearance of being sound; but considering the nature of lead, one would think that the expansion and contraction that lead is subjected to would soon cause the welt to become loose, and very quickly leak, especially under high pressure.

There is another very ingenious method of making joints,

FIG. 64.

which, I understand, was in use to some extent in the North of England. Fig. 64 shows a section of one of these joints. When a straight joint is required, a piece of thin brass tube, just large enough to fit inside the pipe—with the outside tinned—is inserted in the ends of the pipe. A space is left between the ends of the pipe as shown. A gun-metal or iron mould is then fitted tight round the pipe. This mould has a pouring-hole on one side, and an outlet on the other. The solder is poured into the mould and allowed to overflow for a short time, until it is supposed the ends of the pipe are well tinned. The brass tube, of course, prevents the metal running inside the pipe, and at the same time forms part of the joint. This is the best style of machine-made joint that has come under my notice; but as regards its practicability one cannot say anything without he has used it, or had some

other practical experience of its utility. There can be no doubt as to their soundness if carefully made, that is, for a time; but in the case of hot-water services there is a probability of their giving way.

When a branch joint is made, a tee-piece has to be used, as shown at Fig. 65. Therefore it is necessary to cut the main pipe in two at the branch to get the tee in. The mould is then placed on the branch, and the solder poured in as before described. I suppose it is necessary to have a different size mould for each size and weight of the pipe, and for every kind of branch. If it is so, it is necessary to have

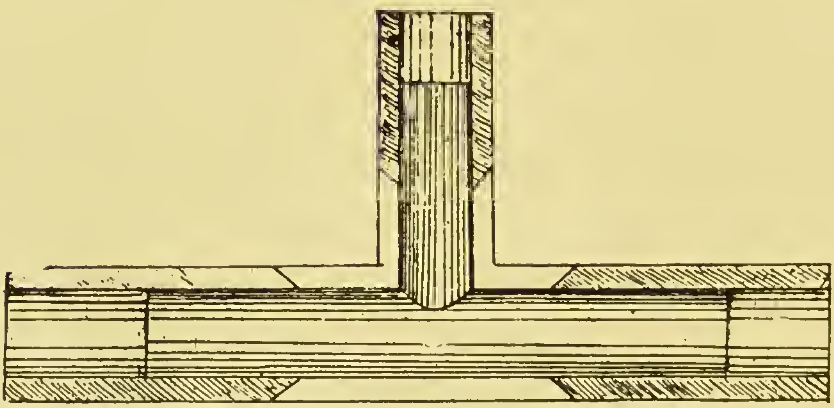

Fig. 65.

a very large amount of apparatus, compared with the plumber's wiping-cloths and an iron or two—not to mention the expense incurred in providing a complete set of these machines for each job that a firm may have on hand.

There is yet another similar kind of apparatus, patented for making joints the same shape as an ordinary wiped joint. This is also a mould for fitting round the pipe, and the joint is cast with solder: but no tube is used inside. The joint is, I understand, prepared in the usual way; the only difference is, the joint is cast instead of being wiped. Whether this kind of joint was successful or not, one cannot say, not having heard anything about it of late years.

The most simple method used for joining lead pipes is what, if I remember rightly, was termed the Coburgh joint. This consisted of two iron flanges slipped on the end of each pipe. The ends were tafted or flanged, a washer being placed between ; the iron flanges were then drawn together with iron bolts and nuts, as shown at Fig. 66. This kind of joint used to be very much in demand a few years ago, principally for repairing main service pipes that were broken by excavators when opening up roads for sewers and iron mains. I do not hear of many being used now, as they were generally found to fail. They were all very well when

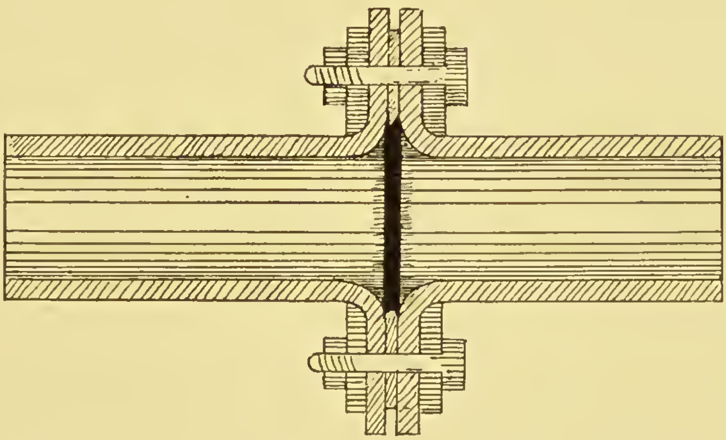

Fig. 66.

first made, but after the earth had subsided a little, the pipe, being disturbed, caused the joints to leak ; the consequence was large numbers had to be taken out, and wiped joints made instead. Fig. 67 is a sketch of another kind of joint for connecting a leaden pipe by means of a brass connector to iron barrel or a cast-iron main. One end is screwed to any required size, the other end has a brass cap for passing over the end of the lead pipe ; the pipe is then opened with a turnpin to fit the cone-shaped end of the connector, after which the cap is screwed up to form the joint.

The one great objection to all these kinds of joints is their

uncertainty. After joints are wiped and once tested, it very rarely occurs that they are found defective. Of course there are exceptional cases, but generally a good wiped joint need not cause any anxiety, in whatever part of a house it is fixed. But when joints of the kind described above are used, there are sure to be doubts as to their permanence. In the case of tin-lined lead pipes, there is no doubt the latter kind of joints are more effectual, because the tin, not being so malleable as the lead, prevents it from getting so loose as it otherwise would. A very large number of joints similar to Fig. 67 have been used for tin-lined lead pipe; the object, of course, is to joint the pipes without disturbing the tin inside. If joints are prepared and wiped in the

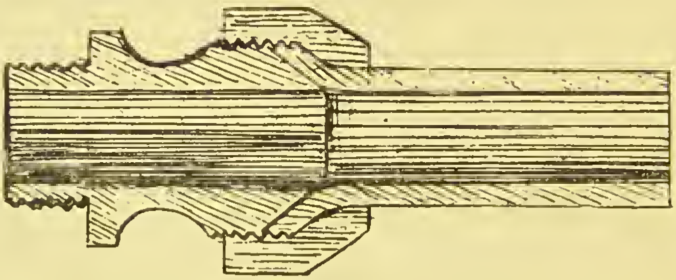

Fig. 67.

ordinary way the tin will melt several inches each way from the joint, and therefore make the pipe much weaker near the joint, besides exposing the surface of the lead, and defeating the object for which it is lined with tin.

Many experiments have been tried to prevent the tin running when the joints are being wiped. Some plumbers have tried to keep the tin on by pasting paper inside. This reminds me of a job where a hot-water circulation was carried out with tin-lined pipe, and where paste paper was used to prevent the tin running. But not only did it not answer the purpose for which it was intended, but when the pipes were charged with water the paper was washed up into different parts of the pipes and stopped them up, and

gave no end of trouble before it was got out again. One very good plan is to fill the ends of the pipe with dry whiting. This will easily wash out when the pipes are charged with water. Other means have been adopted, but the best plan, in my opinion, is to insert a piece of thin brass tube, tinned on the outside. If this is made to fit tight, and the ends of the pipe well fitted together, the tin will not run enough to do any harm, and if it does, the brass tube strengthens the joint and helps to make it more secure.

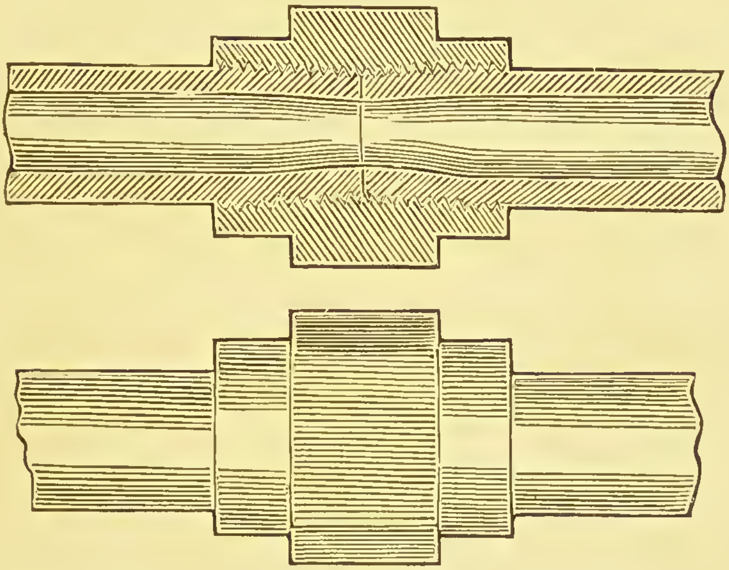

FIG. 68.

Straight and branch tubes, similar to those shown at Figs. 64 and 65, would answer the purpose very well; although in the case of the branch joint the solder would have to pass round the main pipe as well as the branch, thus making a combined underhand and branch joint, similar in section to Fig. 65, but with the solder projecting in the ordinary way.

Recently another method of joining lead pipes has been patented. But like most of the others, in the absence of practical experience one looks upon it with

considerable suspicion. This consists of cutting threads on the ends of the lead pipe and screwing them together by means of a brass coupling, having right and left hand threads; the section is shown at Fig. 68.

It is claimed for it that the joint is much more economical than a wiped joint, and quite reliable. Probably the unskilfulness of the joint gives it the economical character, because a plumber would not be necessary. But nothing is said of branch joints to fittings; where these are required I suppose a plumber would be asked to display his skill.

# CHAPTER XIV.

## PREPARING WIPED JOINTS.

IF plumbers' wiped joints are to hold their own against all the many rival inventions that have been brought before public notice of late years with the object of dispensing with the skilful labour that is required to execute modern styles of plumbing, every effort should be put forth by plumbers—especially the younger members of the craft—to use every means possible to make the wiped joint not only sound and sure, but handsome, and at the same time economical. One objection that is often raised to wiped joints is that they are too expensive, and require a large quantity of solder. Another is that they take up too much time, and when they are made they are said to be ugly, and have been described as a "bulbous patch of solder round a pipe". That these allegations are true in numerous instances admits of no doubt, especially with regard to the things called wiped joints which are made by the numberless botchers that are allowed to call themselves plumbers, who not only bring the wiped joint into disrepute, but cause the trade generally to get a bad name, and prejudice the public mind against plumbing work of all kinds. It seems very unfortunate that plumbers' work should be judged by its worst specimens; but, probably, this course of action is justified by the principle that the strength of the chain is limited to its weakest link. There is no doubt that if joints are carefully prepared and properly wiped the above objections should be groundless, and that for good substantial work

there is no other kind of joint that is more suitable for the purpose.

Now, in the process of making wiped joints no part is so important as the preparation. A joint may be wiped as nicely and as regularly as possible, but if the ends are not properly prepared and fitted, it will very often happen that the joint will leak by sweating, as it is called; the solder is generally supposed to be the cause, but more often it is the fault of the imperfect preparation of the ends of the pipe. We will suppose, for instance, an upright joint on an inch service pipe. Fig. 72 is a sketch showing the way a joint of this kind is usually prepared. Very often one end barely enters the other; no care is taken to see that the ends fit properly together, and any space that may be left between the two ends is knocked up with a hammer. As to shaving inside the socket end, this is thought quite unnecessary, if not a fault, for some think if the socket end is shaved inside, it will induce the solder to run through and partly fill up the pipe. There is no doubt it would do so if the ends do not fit; but that is just the thing that is most important, not only as regards the solder getting inside the pipe, but on it depends, to a very large extent, the soundness of the joint.

The general idea is that if the two ends of a pipe are shaved and placed together, and a piece of solder stuck round them, that is all that is required to make a joint. Of course all practical plumbers know, or at least should know, the results of such a delusion. Especially if the solder is not so fine as it ought to be, it is the cause of most of the leaky joints, and very often the joints are found broken right across the centre, more especially in the case of joints on hot-water, service, and waste pipes. I have also known instances where joints have been made to brass unions, the brasswork has pulled clean out of the joint through nothing

else, as I believe, than the joint being prepared carelessly. It has been remarked before, that the solder is generally blamed for all the failures. It is either too coarse or too cold, or else it must have got a piece of zinc in it. Otherwise, if the joint is made to brasswork, it is that which has poisoned the solder. In short, everything gets blamed except the right.

It must not, however, be supposed that joint-wiping can be taught by articles, nor do I profess to undertake such an impossible task; this can only be accomplished in the workshop or on a plumbing job. But as practice is very often greatly assisted by precept, probably a few hints on the matter of joint-wiping will be helpful to many who have not the opportunities to gain a very large or varied experience. In preparing a joint similar to the one mentioned above, after the two ends are carefully straightened, the spigot, or what is generally called the male end, should be first rasped square, and then tapered with a *fine* rasp quite half an inch back from the end. A fine rasp is mentioned because the rasps that are used by many plumbers are far too coarse to properly rasp the ends of pipes. Generally the very coarse rasps are used; it is difficult to say why, except it is that they are cheaper than the fine rasps; but if the advantages of a cabinet rasp be taken into account, the extra cost would not be considered.

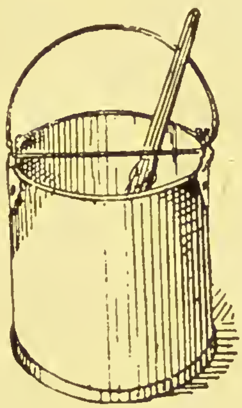

FIG. 69.

When preparing the ends of the pipe, great care should be taken to avoid the raspings getting in the pipes; these cause no end of time and trouble when they get into valves and other fittings, after the pipes are charged with water.

As a rule, it is the back stroke of the rasp that throws the raspings inside the pipe, especially when the pipe is

being rasped horizontally, or with the end of the pipe pointing upwards. Therefore, if possible, when the ends are being rasped, they should either be pointing in a downward direction, or else the rasp should not be allowed to touch the pipe in its backward stroke. Some plumbers place a wad or stopper in the end of a pipe when it is being rasped; this is a very good precaution to take, providing it is not forgotten and left in the pipe. After the spigot end has been rasped, it should be soiled about six inches long, but no farther towards the end than an inch from the rasped edge. Sometimes the soiling is taken right up to the end, but this is not a good plan; because, if it is soiled over the rasped edge, the shavehook does not always take the soil out of the rasp marks, a point which, as I shall presently show, is most important; and as it is quite unnecessary to soil farther than the line of shaving, the soil at the end is quite superfluous. Many plumbers soil the ends before they rasp them with the same object in view, but I do not consider this a good plan, because very often in rasping the ends, the end of the rasp is likely to scratch the soiling, making it necessary to touch up the soiling again.

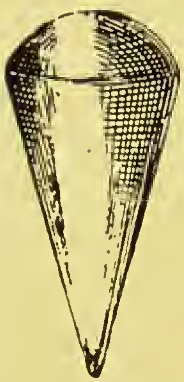

Fig. 70 A

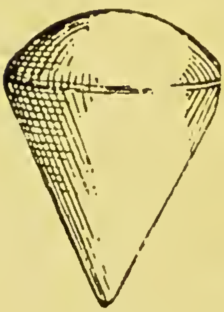

Fig. 70 B.

If the soil is good it is an advantage to rub it, after it is dry, with a piece of carpet or a hard brush—a dry felt will do; this makes the surface of the soil smooth and more durable, and not so likely to flake off when the joint is wiped. Perhaps a word or two about soil would not be out of place here. According to my experience, the best soil is made from vegetable black and diluted glue with a little sugar, and finely ground

chalk added. The proportion of the ingredients depends to a large extent on their quality. Lamp black and size are generally used, but if the black is not very good it is very difficult to make soil fit for use; it will rub or peal off and become a nuisance. Good soil, and a properly made soil pot and tool, are indispensable to a plumber who wishes to turn out a good bit of work. Any makeshift does for a soil pot with a large number of plumbers. Some have an old milk-can or a saucepan, others use a gallipot. It is much better to have a good copper pot, with a handle, like Fig. 69. Most plumbers should be able to make a soil pot with a piece of sheet copper, otherwise a coppersmith would make one for a small sum. Before soiling the end of the pipe, it is always a good plan to chalk it well. This will counteract the effects of the grease that is nearly always found on the surface of new lead pipes. If the pipe is very greasy, it is still better to scour it well with a piece of card-wire before it is chalked and soiled. The scouring is not always necessary, but it is always best to carry a piece of card-wire in case of need.

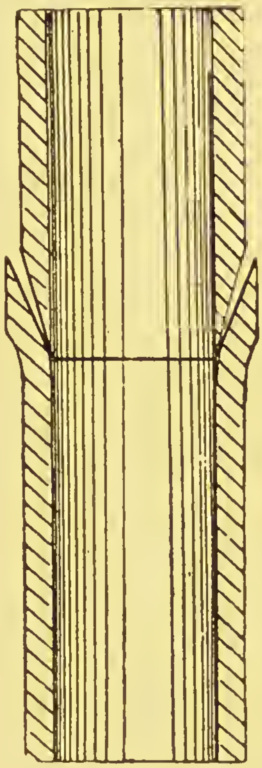

Fig. 71.

When the end of the pipe has been properly soiled and dried by heat, applied inside the pipe if possible, say with a small hot iron, it should be shaved the length required, that is, about half an inch longer than half the length of the joint, thus allowing half an inch for socketing into the other end. Grease, or touch, as it is called by London plumbers, should immediately be rubbed over the shaved part to prevent oxidation. The socket end of the pipe

should now be rasped square and opened with a long tapered turnpin—a short stumpy turnpin is not a proper tool for this purpose, although so many of this kind are used. Fig. 70 A is the most suitable shape for a turnpin, but Fig. 70 B is a shape very much to be condemned. After rasping the edge of the pipe, the rasped part should be parallel with the side of the pipe, as shown at Fig. 71. It will be seen that, although one pipe sockets well into the other, it is not at all necessary for the edge of the socket end to project, nor to reduce the bore of the pipe in the joint; but if the ends are prepared, as shown at Figs. 72 and 73, it would be necessary to open the socket end an extraordinary width to get the same depth of socket, and then a much larger quantity of solder would be required to cover the edge, which would make the shape of the joint look ugly, and not make such a reliable joint either.

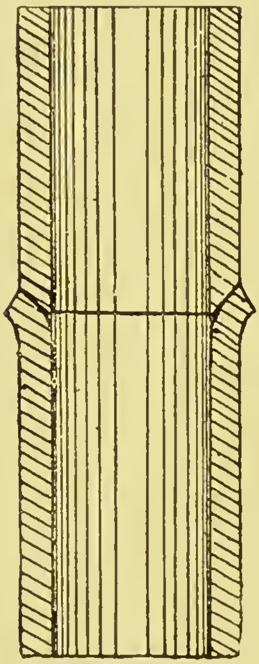

Fig. 72.

When the socket end is properly fitted, it should be soiled and shaved half the length of the intended joint. The inside of the socket should also be shaved about half an inch down and touched.

Now if a joint is prepared in the way described, it will be understood at once that if the solder is used at a proper heat and splashed on quickly, so as to well sweat the solder in between the two surfaces where the ends are socketed, the joint is made, so far as the soundness is concerned, independent of the wiping or the form and shape of the solder when it is finished. In fact, if a joint is prepared in a proper manner, it would be sound in most instances if the solder was wiped bare to the edge of the socket end. Of

course, it would not be advisable to do this; but still, a joint should and could be quite independent of the very large quantity of solder that is frequently used. But when a large amount of solder is seen on a joint, it can generally be taken for granted that the plumber that made it, when he prepared the ends, took great pains to close up the edge of the socket end to the spigot end so that it fitted tight; so tight was this edge, that it prevented the slightest particle of solder getting in between. The consequence very often is, that if the plumber is not quick at wiping the joint, and keeps the solder moving until it is nearly cold, or at least cold enough to set, the whole of the solder on the joint will be in a state of porousness; or, in other words, instead of the solder cooling into a compact mass, the continual moving of it by the act of wiping causes the particles, as they become crystallised by cooling, to be disturbed and partially disintegrated. The result is, that under a moderate pressure the water will percolate through the joint and cause what is generally termed sweating. Very often it is rather more than sweating—it can more correctly be compared to water running through a sieve. Under some conditions it is not a very easy matter to prevent this sweating, especially if the solder is very coarse, or is poisoned by zinc or other deleterious matters. The great advantage of leaving the socket end open is, that if the solder is used at a good heat, as of course it always should be when it is splashed on, it runs into the socket at such a heat that, when it cools, it sets much firmer than

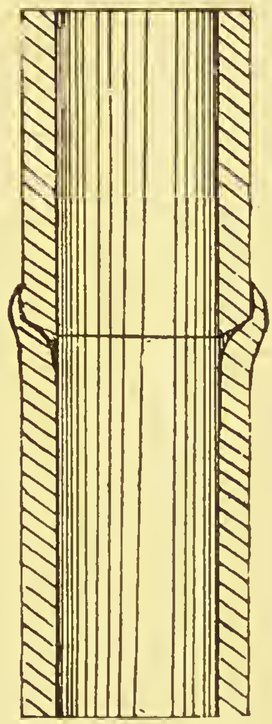

FIG. 73.

that part of the solder which has been disturbed by the forming of the joint; and taking into consideration the extraordinary amount of wiping a great many plumbers seem to think an upright joint requires, it is very important that something more than the chalky-looking formation that is generally produced should be previously arranged to make it more certain to serve the purpose intended.

There are some who are in favour of blown joints, because, as they truly say, they are never known to sweat. The reason is that the solder in a blown joint cools in a natural state and is not disturbed during the process of cooling as it is in the case of a wiped joint. If therefore a joint is prepared in a proper way the advantages of both methods are obtained.

# CHAPTER XV.

## JOINT FIXINGS.

ALTHOUGH it was insisted upon in the previous chapter that a joint on a service pipe should be prepared and fitted in a particular manner, and that every care should be taken in the preparation to make the joint as sound and as perfect as possible, it must not be supposed that a joint cannot be made sound by other means. But that is not the question. It should be the object in joint-wiping, as it is in many other branches of mechanical work, to so work the material as to obtain the greatest amount of efficiency that circumstances will allow without waste of materials.

If half a pound of solder can be made to answer the purpose—of course without scamping—why use a pound?

It is generally accepted as a sound principle that if a larger quantity of materials is used than is necessary for a good job, it is considered so much waste.

Therefore, if joints can be wiped light and neat, and at the same time be perfectly sound and reliable, why wipe them so heavy and shapeless as they very often are? There are many instances where it is not only unnecessary, but not at all advisable to prepare joints as just described. But those would be cases where they have to withstand little, if any, pressure. Soil-pipe joints, for instance, should be treated in a different manner; but the reasons we must leave until another time, when on the subject of soil-pipe joints.

The next important matter in connection with the

making of a joint is the fixing that is necessary while the joint is being wiped. Of late years several kinds of cramps, or a sort of vice, have been invented for fixing the pipe while the joint is wiped.

Fig. 74 is a sketch of one of these pipe fixers. No explanation is necessary, as the machine explains itself.

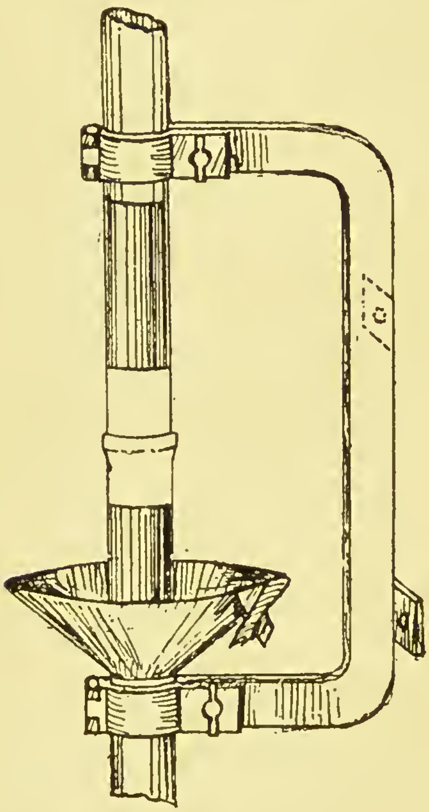

FIG. 74.

Whether this kind of fixing is convenient or not I cannot say, not having seen one in use, but there is no doubt it is useful in many cases where chisels or spikes cannot be driven into the walls, although it seems to me that the cramp would require nearly as much fixing as the pipe, under ordinary circumstances. In my opinion there is no better way to fix a joint than that shown at Fig. 75. If one or two chisels or spikes are driven in the wall about four inches below the bottom of the joints, as shown, and then the pipe tied to them with string, it can be made as firm as possible. Another spike should be fixed above the joint about six inches, and the pipe tied to it the same as below. No plumber's kit should be considered complete without three or four round steel spikes about eighteen inches long and from three-eighths to a half-inch in diameter, for fixing purposes. Spikes of this kind are much better than large chisels, because they do not make such large holes

in a plastered wall, or anywhere else where they have to be driven in. Although it is absolutely necessary that the pipe should be fixed perfectly rigid to prevent the joint breaking when it is being wiped, yet one would think that

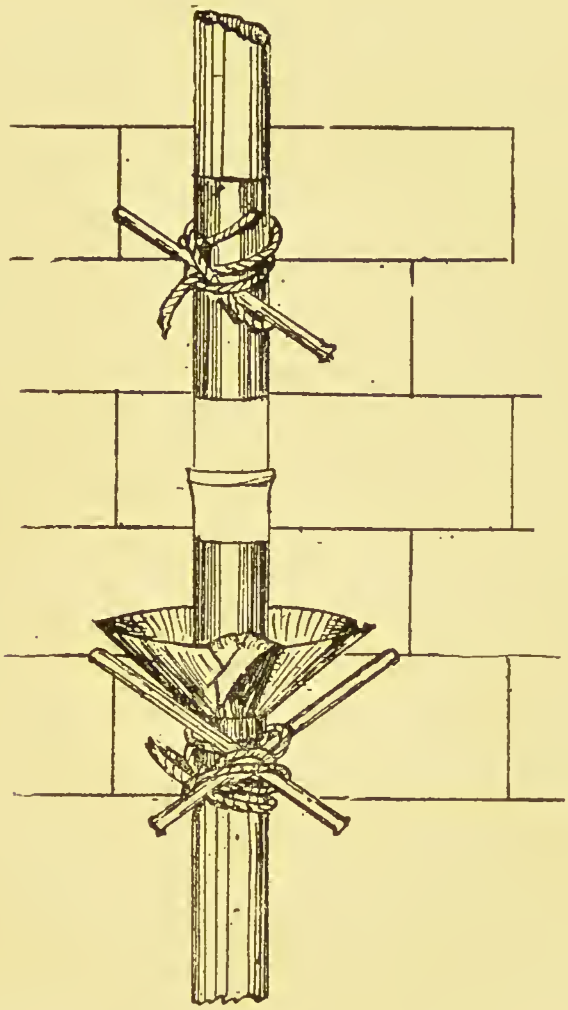

Fig. 75.

some of the means used for this purpose were intended for permanent fixings, instead of only being required for a few minutes.

There is a very great difference with plumbers in this respect; some will only require one spike and two or three

wooden struts to fix a joint as firm as possible, and others will drive so many spikes into a wall, that they find it difficult to get at the joint in a proper manner, for their fixing is all in the way, and a nuisance to them. Careless fixing should be greatly condemned, because it very often happens, if the pipe is not secure, that in finishing off the joint the pipe will move with the pressure of the hand, and break the joint, although it may not be perceptible until after it is fixed in its place, and charged with water. Therefore a little care in the first instance will often save a great amount of trouble afterwards.

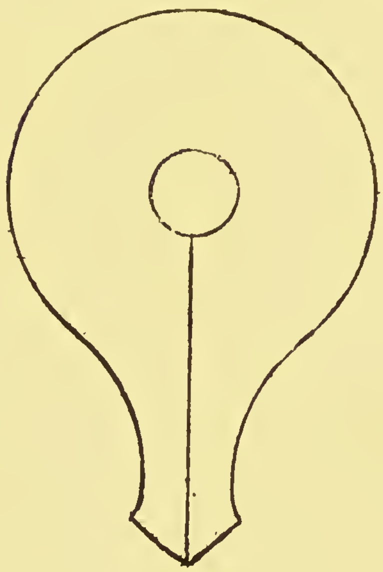

Fig. 76.

When the joint is securely fixed, a collar should be placed round the pipe, as shown at Fig. 75, to catch the solder. Fig. 76 shows the pattern of a collar; the long points are used to fold one over the other so as to hold it tightly round the pipe. Paper is very often tied round the pipe to catch the solder, but this is a very clumsy and wasteful plan to adopt; not only is the solder wasted, but it is also thrown about, and causes much damage to paint and other work. When a piece of sheet lead is not at hand the next best plan is to cut a piece of cardboard to the same shape, as shown at Fig. 76. This can be made secure with a piece of string, and will answer the purpose very well. It need hardly be mentioned that the lead collar should be well soiled on both sides before it is used. After use it should be cleaned with card-wire and resoiled ready for the next joint.

On well-regulated jobs a stock of lead collars of all sizes is always kept prepared, and all ready for use.

Now when the joint is ready to be wiped—if matters have been properly arranged—the mate or labourer should have the solder hot and ready for use. As much depends upon the solder being in a proper condition, it is well to know the most favourable heat in which to use it. Most experienced plumbers have no difficulty in judging the proper heat of solder for the job in hand. All they need to do is to pass the back of the hand over a ladle full of solder. The degree of heat felt by the hand is quite sufficient to indicate the temperature as to whether it is too hot or not hot enough.

It would be impossible to describe the exact effect that solder at a proper heat has on the sense of feeling, because some are more sensitive than others in this respect; besides, the most suitable heat for one kind of job would not be so convenient for another, therefore the ability for judging the heat of solder must to a great extent be gained by experience. There are other means used to test the temperature of solder, and which have to take the place of what may be called the more skilful means. One is to place the end of a stick of dry wood in the molten solder; if this chars very quickly, the solder is hot enough for use. Another plan is to fold up a piece of paper like a large pipe-light, and thrust it into the solder; if it is hot enough, the paper will ignite at once, but if not it will only scorch away. Some strike the edge of the pot with a felt; if the dust off the felt produces sparks on the surface of the solder it is supposed to be hot enough. The thermometrical temperature of solder when ready for use ranges between 700° and 750° Fahr.; but this way of stating the temperature is of no use in ordinary circumstances, because no one would think of using a thermometer for this purpose. The wiping heat of solder, or, at least, the heat necessary to produce a proper wiping heat, is considerably above its melting point, that being 440°. The extra heat is easily discovered by amateurs, especially when they are

pouring on an underhand joint, although upright joints have had to suffer from the injudicious application of the solder in the first instance. It is very astonishing to some how quickly the metal finds its way through the pipe when it is not splashed or poured on skilfully. When splashing the solder on the joint of a service pipe like that under consideration, it is very important that care should be taken not to melt the pipe away at the top of the shaving. It very often happens when the solder is used rather hotter than necessary, that the back of the joint is made very much like that shown at Fig. 77. The solder being wiped bare at the edge causes this to be a very weak point in the pipe, whereas, if it is properly done, it should be the strongest. Consequently when the solder is first splashed on it should be done very carefully until the whole of the shaving is covered. When a thin coating is on, it is a good plan not to splash on too much in one place, so as to expose the bare tinned surface, but when the surface of the pipe is shown draw some of the partially cold solder over the part exposed, and continue splashing on the other solder. If the falling solder is continually drawn up with the splasher there need be no fear of the joint not being tinned. This is sure to take place without repeatedly splashing on to the bare surface of the pipe.

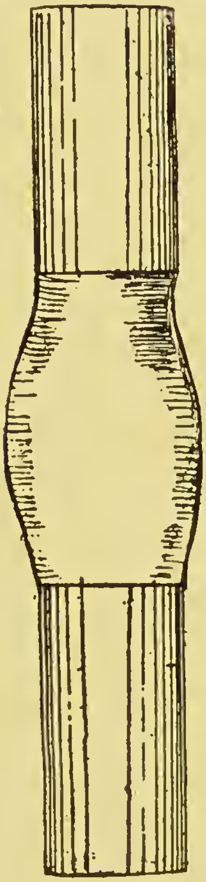

Fig. 77.

The splasher, or, as some term it, splash stick, should not be a stick, as it very often is, but a piece of thick sheet iron cut to the shape shown at Fig. 78. A piece of string bound close and tight round the handle forms a good hold,

and serves as a non-conductor against the heat from the end in use. Wooden splashers are a great nuisance; the heat of the solder burns them, and the smoke gets in one's eyes when making a joint, especially if they are used in confined places; and then the charred ends break off and get in the solder. The best that can be said of them is they are only makeshifts.

Some plumbers object to iron splashers because they say the iron scratches the soil when drawing up the metal to the joint; but this occurs only in the case of badly made splashers. If the edges are left as rough as a saw, of course they will scratch, but if they are made from sheet iron about a sixteenth of an inch thick, and the edges filed or ground round, the difficulty is soon overcome.

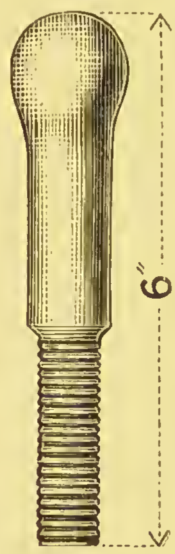

Fig. 78.

One of the principal causes of failure to make a good joint, especially with young plumbers, is the insufficient heat raised on the joint in splashing on. It is not enough that just the quantity of solder necessary to form the joint is splashed on, no matter whether an iron is used or not. The splashing should be continued until the whole of the solder on the joint is in such a condition that it is with difficulty made to adhere to the pipe; if it remains on the pipe, without continually being patted and drawn up with the splasher, it may be concluded that the heat is not sufficient to wipe the joint as it should be. Therefore do not be afraid of getting up too much heat, providing the solder is not splashed on the bare pipe.

Now the next question is concerning the plumbing iron. To a very large extent, in some of the best shops, this useful but much-abused tool is being discarded. The rage is to make joints of all sizes and shapes without using an iron.

It matters not what the conditions are, there seems to be a sort of bravado actuating a great number of plumbers lately, to be more clever than those of more experience. But the worst of it is, in most cases, those who want to make joints without what was once considered as indispensable, are generally, as far as my observation goes, those who have not learned how to make a joint properly *with* an iron. Of course there are notable exceptions, but it seems to me, if one or two good men should do anything out of the ordinary way, nearly all the younger members of the craft use every endeavour to follow them, regardless of the consequences. It must not be supposed that my intention is to condemn any legitimate and proper desire on the part of young plumbers to become as skilful as those who have had more practice and experience. But the question is, whether it is not better to walk before attempting to run, or to produce a certainty rather than an uncertainty. The latter remark is very applicable and appropriate to the subject, because there are plenty of plumbers who will make a joint with an iron without any difficulty, but when they attempt it without an iron it is generally nothing more than an experiment, and requires several fresh heats before it is accomplished, and then not in a very satisfactory manner.

One of the most important things in connection with joint-wiping is to know the nature both theoretically and practically of solder. It is not enough to know that solder by the aid of certain manipulations will form a joint, or serve under some circumstances as a fixing for a pipe. This, unfortunately, is the extent of the knowledge of a vast number of the present-day plumbers. It is not so much the making of the solder in which the lack of knowledge lies, as in an intelligent use of it after it is made, and is in the pot ready for use. We shall have something to say later on on the manufacture of solder; but as plumbers in

these days have very little to do with its manufacture—as it is generally made by men specially employed for the purpose by merchants and others—it is of no immediate importance, or at any rate not so much as the subject of its treatment in the hands of the plumber. The above remarks are naturally suggested by the use or disuse of the tool already mentioned, namely, the plumbing iron. If the composition and peculiar changes that take place in the use of solder under different circumstances were taken more into consideration, the iron would be valued very much more than it is, by a large number of plumbers, who at present seem to consider it very smart and clever to dispense with its aid. Not that it is absolutely necessary to use an iron to all classes of joints; this is not my contention, because there are some kinds that can be wiped just as well without an iron, that is, providing they are made by a skilful plumber. But the principal object should be to use proper discretion, and to use the means most suitable to the circumstances.

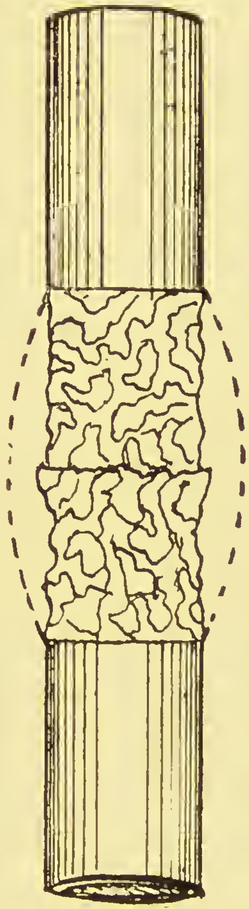

FIG. 79.

In the first place, those who make joints without irons, very often with the object of making sure of a good heat, have the solder made very much hotter than is necessary, with the result that the solder becomes deteriorated and sometimes nearly useless for its purpose. Very often the heat is raised to over 900°, or about 200° Fahr. more than it should be. If the solder is subjected to such a heat two or three times, or only once for a considerable length of time, it is said to be burnt.

But what really takes place is, the tin in the solder

becomes oxidised. Tin, being much lighter than the other constituent lead, will always rise to the surface after the solder is fused ; this is explained by the fact that the specific gravity of tin is 7·5, but lead is 11·352. Therefore, when the solder is raised to a high temperature, the tin being exposed, it absorbs the oxygen of the atmosphere and by this means is converted into what is termed putty powder or tin putty. This substance is generally called and supposed to be dross, but of course this is a mistake, because dross, properly speaking, is an impurity or something foreign to the substance it is extracted from, but this putty powder is simply tin and oxygen. Chemically, it is a mixture of the protoxide SnO, with the binoxide $SnO_2$ of tin ; it is very hard, and is used to a large extent for polishing marble, glass, and metals.

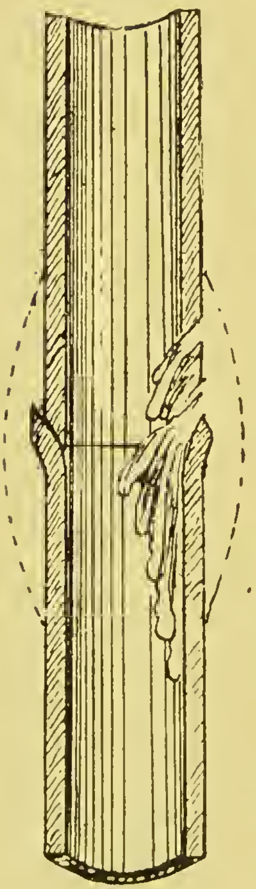

Fig. 80.

Now, although putty powder may be very valuable for purposes apart from plumbing, its formation on the surface of molten solder means so much loss to the plumber both as regards its utility and appearance, whether it is used for joint wiping or otherwise. Therefore, for this one reason alone, if not for anything else, it is much to be preferred that an iron should be used to help to sustain the heat while making a joint rather than that the solder should be heated to an extraordinary temperature, and consequently spoiled and unfit for use. Another result of overheated solder is, if the plumber is not extremely careful, or if a joint has to be wiped in a very awkward place, when it is first splashed

on it melts the surface of the pipe more or less all over, as shown on Fig. 79, and in many instances a hole is burnt through the pipe either at the top edge or else at the edge of the socket end, and the pipe is nearly filled with solder similar to that shown at Fig. 80. If the only result is that the surface of the pipe is melted, the effect is very much the same as it is if the solder is overheated; because the lead melted—or as it is generally called burned—off the surface of the pipe mixes with the solder on the joint, and consequently makes it coarser; the only difference is, instead of the quantity of tin being reduced more lead is added, which has a similar effect. Sometimes it occurs that when the very hot solder fuses the pipe, the very coarse alloy which is formed drops into the socket in an irregular manner and prevents that sweating between the two surfaces which was mentioned as so important in the previous remarks on the preparation of the ends of the pipes. Then the solder being coarser on the joint, it is very weak and porous, and sweats rapidly with only a small pressure of water.

Overheated solder also produces another effect which is commonly observed by those in the trade. There is no doubt that tin and lead mix or form a most perfect alloy at a temperature a little above the melting point of solder. But above or below this condition they have a tendency to become separated, in the former case by gravity, and in the latter by the natural laws of crystallisation. So that when using solder very hot it is difficult to keep it amalgamated, or at any rate to the extent it should be to answer its purpose in a proper manner. The complaint is frequently heard when a joint is being wiped that the solder is too fine. It is supposed that because the tin is continually running to the bottom edge of the joint, draining away from the bulk of solder, there is more tin in the solder than will properly combine with that already on the pipe. Many

plumbers will say they cannot use such fine solder, and often put a piece of lead in the pot to lower the quality of the solder. In a very large majority of cases this is a great mistake; the simple reason is, that solder is not fairly used.

No one can dispute the fact that the finer solder can be used—whether it be for upright or underhand joints—the better it is both for the look of the work and for its soundness and utility.

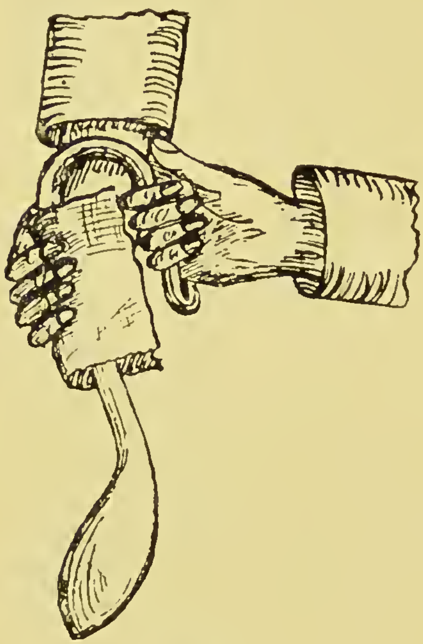

Fig. 81.

Nothing in plumbing looks more smart than to see joints look bright and clean, and whenever this is the case there need be no fear as to their perfect reliability.

But when one sees joints with a dirty, chalky appearance, the surfaces of which are rough and porous, there is always a doubt about them; the plumber should have a smooth-faced hammer in his hand when he is testing them, for he is very likely to require it for tapping up their sweating surfaces. Of course, these joints answer their purpose where they do not have to sustain pressure, or if they do, their preparation has most to do with their soundness; but it is always best to be on the safe side, especially when the safest way is the easiest and generally the most convenient; consequently the best means should be adopted to make a joint look bright and clean.

Now, if means are not used to prevent the tin running away from the solder while the joint is being wiped, the result will almost invariably be a dull, coarse joint. Of

course, it is impossible to prevent a certain small quantity of tin showing at bottom edge of some joints, such as large branch joints and some others, which will receive notice in their turn, but in the case of small upright joints it is easily prevented by proper and skilful manipulation. My advice to all beginners in joint-wiping is, by all means learn to use an iron, especially for upright joints; it can easily be dispensed with after a man has become thoroughly proficient, that is, if he finds it best to do without it, as no doubt he can under some circumstances, but if an iron may not be absolutely necessary in certain cases, it certainly is never detrimental to any kind of joint, whether it is an underhand or upright. Therefore when the solder is splashed on the inch upright joint under consideration, take an iron that has been well cleaned with an old file, generally called a "rubber". It is not a good plan to use an iron very hot, because the effect on the tin is much the same as it is when overheated in the pot. The iron in proper condition should be heated to a dull red colour; if it is above this heat, the tin will oxidise and coat it with a yellow powder, or, as before mentioned, putty powder. Of course, it burns the lead in the solder to a certain extent, but it has most effect on the tin—this also spoils the quality of the solder. Much depends on the attention paid to the irons by the mate. Generally, the irons are treated very carelessly; they are left in the fire for any length of time to burn away and get coated with thick oxide. When they are wanted, they are drawn from

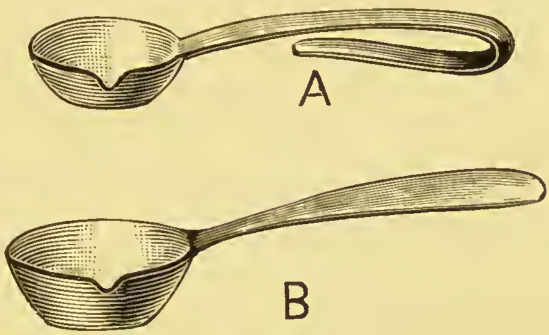


FIG. 82.

the fire and plunged into a pail of water, to reduce the heat and to crack the coating of oxide, so that they will clean easily. This is far from proper treatment; it should be the business of the mate to watch the irons to see that they do not get too hot. Then they would not only not require so much cleaning, but they would always be in a better condition and not have holes and cracks in them. If irons were properly looked after, they would want no more cooling than just the handles quenched before they are taken to the plumber; this, of course, should never be neglected, not only because of the difficulty of holding them, but on account of the harm they do physically to the persons who have to handle them.

The shapes of plumbing irons differ to some extent. There is one thing about them that it may be well to mention—that is, concerning the handle. This should not be too long nor thin; a short thick handle is the most convenient form to use, with the bulb as shown at Fig. 81. Long thin handles make the wrist ache very much, and cannot be held so firmly as those with good thick handles. Some have asked why the handles are made with a hook. This is easily explained by their use. If irons were made with straight handles, it would be very difficult for the mate to hand them to the plumber, because red-hot irons are not safe things to lay down anywhere so that they can be picked up again by the plumber—it would be a very dangerous practice. Consequently the hook is made so that they can be handed from one to the other conveniently, as shown in the sketch.

Then with regard to the ladle; instead of cutting the handle short, it should be turned under as shown at Fig. 82 A; this forms a better handhold than simply a thin end. Some have a handle forged like Fig. 82 B; this is an excellent plan and makes a good handle. The bottom of the ladle should be flattened a little as shown, to prevent its turning over when resting on anything.

# CHAPTER XVI.

## PLUMBING IRONS.

BEFORE proceeding further with this subject, I think the advantages of the use of the old plumbing iron demand a little more of our consideration. Not that men of mature experience require any hints with regard to its advantages, under proper conditions. But the fact is, there are a large number of young plumbers growing up who profess that they cannot use an iron to assist them to make joints. They seem to have an idea that to use an iron is discreditable to them in this age of sanitary progress. Some seem to think that the plumbing iron belongs to the age of pan closets and D traps, and that the use of irons should die out as if it were an unsanitary fitting.

Now, there can be no doubt that the desire to improve on the old-fashioned styles of plumbing is not only commendable, but imperatively necessary. Yet it is well not to advance so fast as to forget the fact that there are many things worth learning that were prevalent in the old times of plumbing. The greatest fault of old-fashioned plumbing was the defective system on which it was carried out, owing to ignorance that existed of sanitary laws, and the deadly effects of various vapours generated in soil pipes and drains.

But it cannot be denied that the work done by good plumbers of years ago had the credit of being strong and substantial—that is so far as the workmanship is concerned.

Of course, botchers existed in those days, as unfortunately they do now. But when plumbers—who are worthy of the name—made a joint or soldered a cistern or a tack, they used the best means to ensure their strength and soundness; and there is no doubt that the idea of overcasting a joint with an iron after it was wiped was a good principle to work on, although it may not have been absolutely necessary in all cases. They knew very well—although probably not able to explain it scientifically—that overcasting a joint was a sure preventative against sweating, and that it was also proof against the air passing through a joint on the suction of a pump. That some wiped joints will allow the air to find its way through them has been proved in numerous instances, much to the trouble and annoyance of the plumbers concerned. Now, it is not my intention to advocate the return to the practice of overcasting joints, because it is undoubtedly quite unnecessary, as I have already stated. But my object is to try to show the folly of dispensing with the iron to upright, and especially branch joints. Not that it is impossible for some plumbers to make a good joint without an iron, although I believe they could do it better with one. But the evil is in the impossibility of all plumbers making good joints without the aid of irons, and it becoming the fashion to do without them altogether, notwithstanding the fact that many are mere botchers with the solder, simply because they have a fancy that to use an iron is old-fashioned, and

FIG. 83.

a sign of unskilfulness. I must confess that this was my own idea at one time, and no thoughts of an iron for joints up to the size of four in. were entertained. But experience has taught me that as a universal practice it is a mistake.

The object of overcasting joints was to melt the solder on the surface, so as to allow it to cool in a more natural and undisturbed state; consequently the particles adhere much more closely than they generally do on a wiped joint. But if a joint is wiped hot and finished quickly, the result is very nearly the same as it would be if it were overcast; therefore the main object should be in wiping joints, to adopt the best means that will allow the solder to cool in as undisturbed a state as possible.

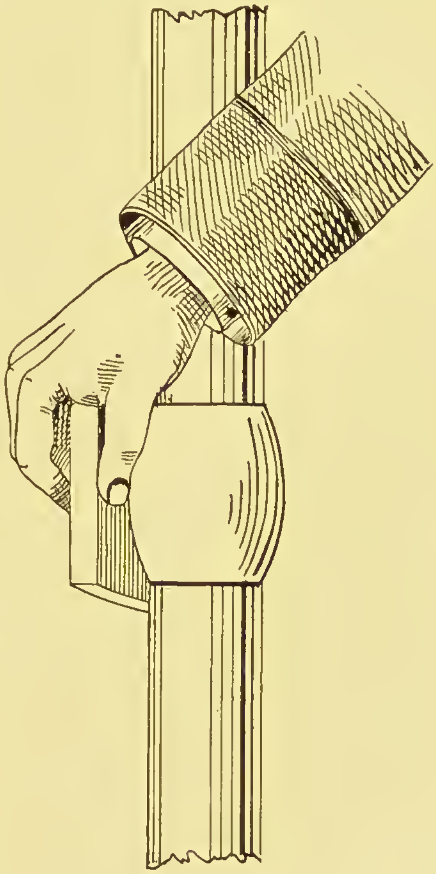

Fig. 84.

Now, the principal faults in making joints without irons are, first, the solder is splashed on so hot that the tin runs away from it to a large extent, which would not be the case if the solder was used at a more reasonable temperature. Then the plumber is in such a hurry, for fear he should lose his heat, that he has no time to draw up his bottom solder, and thoroughly remix, as it were, the solder on his joint, but proceeds to wipe round his top edge as clean as he can—which is not very clean generally (see Fig. 83), for there is very often a bright edge where a knife has been used to trim it off.

After hastily clearing the top, he now begins to form the joint into something like the shape required. All this time, which of course is not many seconds, the solder is losing its heat, and the tin is draining towards the bottom edge. But the plumber has no time to pay any attention to this; he continues to wipe round and round the joint until the solder is too much reduced in temperature to adhere to his cloth, except in the form of small particles like grains of sand. A good soaking with touch and a wipe with a rag finishes the joint. The result is a chalky-looking bulb, with a bright edge round the bottom edge where some of the tin has run after the wiping is done. The real state of the case is, the joint has been over-wiped; the cloth has been over it about six times more than it ought to have been. Instead of so much manipulating with the cloth, the less a joint is wiped the better, and the quicker it is formed and finished the brighter and more reliable it is. Although it may seem strange to say it, yet it is a fact that if an iron is used it is not at all necessary to be in such a haste when wiping a joint; yet at the same time a joint can be wiped quicker with an iron than without one. This is a good illustration of the saying: "More haste, less speed". This, I maintain, is true if the joint is made with the first heat, as it of course should be. But when we take into consideration the amount of time lost through having several heats to one joint, when it would have been almost certain with the first heat if an iron were used, one cannot help insisting upon the advantages of their continued use, even to a greater extent than some of my more skilful readers will think absolutely necessary.

After the solder is splashed on as before described, the iron should be drawn over the solder from the bottom to the top edge, following each stroke with the cloth all round the joint; at the same time patting the solder roughly into shape,

and finishing this process at the back. From this part commence to wipe, being careful to get the top edge clean first. Do not attempt to wipe the solder when it is nearly set, but keep it well warmed up with the iron, following the iron closely with the cloth. By all means avoid wiping the surface of the joint too many times ; the less the cloth is used the better the joint is in every respect. When one side is finished, which it should be in very much less time than it takes to describe it, wipe the other side in the same manner, being careful to well warm the solder at the back where it joins the part already done. It is not always necessary to change the cloth from the right to the left hand when one side is wiped ; because with a little practice the right hand can be turned over, and the other side wiped with the cloth the other way up. Fig. 84 will give some idea of what is meant. In the case of a large joint this cannot always be done, as it is rather difficult to reach round to the back ; but with small joints it is much more convenient to finish the joint without changing the hands with iron and cloth where it is possible to do so.

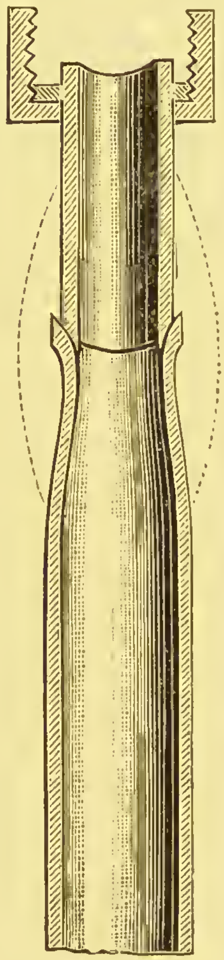

FIG. 85.

As a rule most plumbers like to finish off with the right hand, so that it generally involves two changes ; in the meantime it often happens that the heat is lost, especially if the metal should happen to be rather coarse, or otherwise not very good. Now when the two sides and back are finished, and the surplus solder is drawn to the front, rub the iron well into it, and draw down from the top with the cloth, and finish off at the

bottom edge. Never mind about the wipe-off being seen; if the joint is a good shape and wiped clean, the wipe-off is no detriment to it. Some plumbers will keep on wiping backwards and forwards so as to hide the wipe-off; this, in my opinion, is a mistake, for it generally looks far worse than a decided looking wipe-off, because it disturbs the solder after it is set, and makes it look white and chalky, and very often spoils the joint. Among the younger members of the craft there is too much playing with the solder; they are not content to let well alone. It cannot be too often stated that a good joint-wiper must be quick and energetic, because it must be remembered that an iron, or any number of irons, will not enable the plumber to keep his heat up for an indefinite length of time. An iron will only assist him for a very limited period, just to keep the solder alive long enough to get it into shape, but after that, the sooner it is left alone, the better.

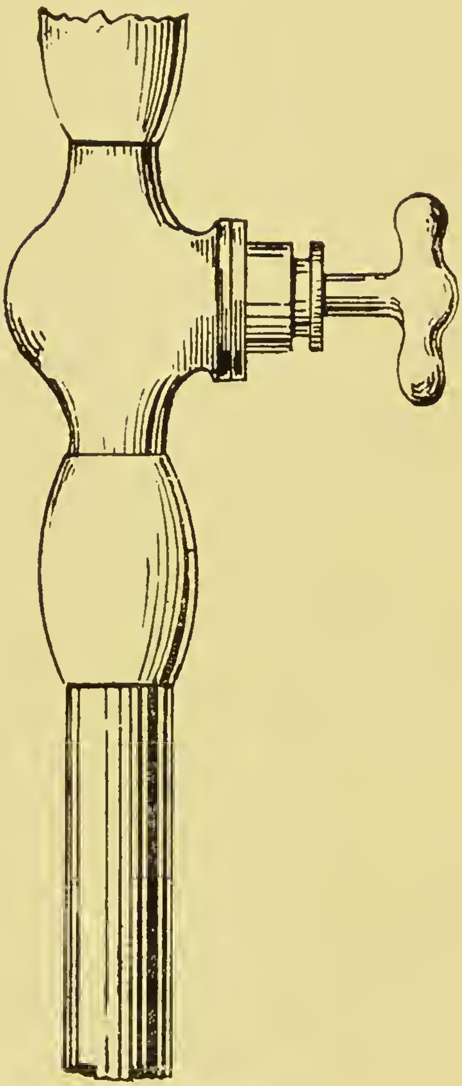

FIG. 86.

The above style of making joints with an iron I hold to be the most simple and effectual, and by far the best way

to learn to make joints. But when a plumber has had considerable practice and experience he, of course, is able to manipulate the solder in such a way as to be independent of many helps and other things which, to the novice, are indispensable. A good plumber should be, and generally is, inventive, and is always finding out different ways of doing things ; while one man is looking and thinking about a certain job, another man is able to get half way through it, therefore it is impossible to hold to any hard and fast rules, whether in joint-wiping or any other branch of the trade.

I have known some plumbers, who do not care to use an iron, to use two cloths to make an upright joint, one in each hand. By this style a joint can be wiped very quickly. After drawing up the solder all round the joint, they start at the back, wiping each side simultaneously, and finishing off in front much in the same way as that described when using an iron. This is undoubtedly the best plan to adopt when an iron is not used, because the joint can be wiped in nearly half the time, and while the solder is hot and bright. Two cloths are rather awkward to use at first, but with a little practice they will be found to be very convenient, especially when wiping large joints. It is of course obvious that two cloths could not be used with any advantage to very small joints, such as Figs. 85 and 86, because they would not only be in the way, but in cases where brass unions or valves have to be wiped on upright, it is much better in every way to use an iron, as the solder generally cools so quickly on the brass edge, more especially on cocks and valves, where there is a large body of metal to conduct the heat away from the joint. There is another thing that should be considered with regard to joints on brasswork. When an iron is not used a great deal of pressure is generally required in wiping to make the joint, owing to the solder

getting set before the wiping is finished; consequently a more elaborate fixing is required than is the case when an iron is used, because the iron, in keeping up the heat until the last wipe, enables the plumber to wipe the joint with a lighter touch, therefore making a lot of very strong fixings quite unnecessary, as the probabilities of breaking the joint are very slight.

Among many plumbers who prefer to dispense with an iron, it has become the fashion to what is called "wash" the joint after it is wiped in order to produce the bright surface which is so desirable. This is done after the joint is just set, by splashing on some solder which is just losing its liquid form. It is indeed in the condition alluded to at page 139; when the tin has a tendency to run away from the particles of lead, it then seems to be absorbed by the porous surface of the joint, thus making up for the loss of tin in the first process. And when the washing is complete by wiping off the second application of solder the joint is greatly improved in appearance and soundness.

## CHAPTER XVII.

### JOINT FIXINGS.

VARIOUS opinions are continually being expressed concerning the best and most convenient position to fix joints for wiping, whether they should be made upright or underhand. Or in other words, is the horizontal position to be preferred, or the perpendicular, that is, if the circumstances will admit of either plan? Of course this question generally relates to work being prepared on the bench, but when the joints have to be wiped after the work is in its place, it is almost invariably the best plan to make them in the same position as they are to be fixed. Although there are some men who will bend a pipe out of its proper course so as to enable them to make the joint in the position most favourable to their particular fancy, or to suit the style of joint they are most used to, it need scarcely be said that when a plumber does this it generally is a sign of weakness, because a good workman should be an all-round man; he should be able to wipe a joint in almost any position, whether it is upright, underhand, or in a slanting direction. But it is nevertheless a fact, and patent to all who have a knowledge of the trade, that the best of plumbers have their own peculiar methods for wiping joints, and will always try to fix their joints in one particular manner when the circumstances are suitable to their favourite style of wiping.

There are some plumbers who, when they are working at the bench, will fix every joint—especially when wiping on brasswork—upright, while others will do just the reverse,

and wipe nearly everything underhand. As far as the quality

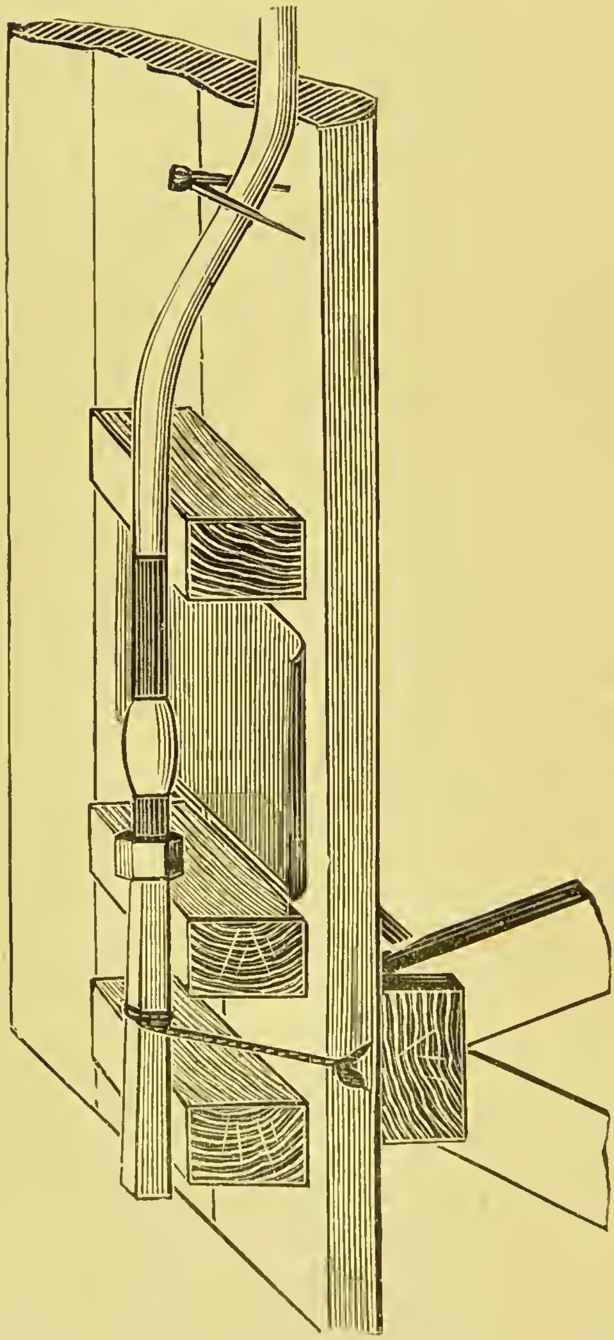

FIG. 87.

of the work is concerned, there is little to choose between

the different methods, providing the joints are properly prepared and wiped quickly.

I have frequently been asked my opinion as to which is the easiest way to make joints. Now as far as the wiping is concerned, there is no doubt in my own mind that upright joints are the easiest, and as a rule the most reliable. But there are many plumbers who prefer to wipe joints—such as those that were shown at Figs. 85 and 86—underhand, not because they are supposed to be more sound or even easier, but in most instances they are more conveniently fixed, and the surplus solder can be caught on a piece of brown paper or soiled sheet lead laid on the bench instead of a collar of some kind that is always necessary when joints are wiped upright. Generally, when fixing upright joints at the bench, especially on small pipes, several struts are required to keep the joint firm while it is being wiped, although some plumbers can do with very much less fixing than others; but if the joint is wiped underhand, only a very simple fixing is required to make it firm enough for wiping.

Fig. 87 shows a joint to a cap and lining, fixed on the bench for wiping underhand. In the first place see that the brasswork is properly tinned; it is not always safe to rely on the tinning as it is received from the brass finisher because it is very often imperfectly done and frequently with bad solder. It is much the best plan to file the tinning off and carefully tin all brasswork with the copper-bit and fine solder, using resin for a flux and not chloride of zinc or killed spirits of salts, as it is generally called. There are some plumbers who think it a waste of time to take the trouble to tin brasswork with the bit, but this is a mistake. If the tinning is not properly done at first, it is generally found necessary to pour on the brass when the joints are being made to such an extent that, when several joints of the kind have to be wiped, the solder becomes poisoned

through the brasswork being heated to such a degree that the zinc in the brass is partially carried off with the surplus solder. But if the brasswork is properly tinned much less solder is required to get up sufficient heat.

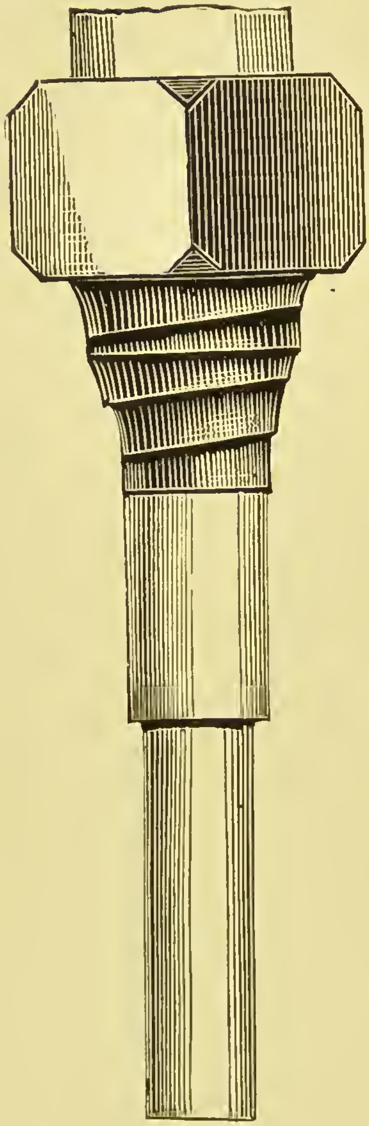

Fig. 88.

There is another thing with regard to tinning that is often considered unnecessary, that is, using pasted paper instead of soil for brasswork. Now there are at least two very good reasons why paste paper is to be preferred to soil for this purpose. In the one case it must be remembered that the great difficulty in making underhand joints on brasswork—particularly if the valves or cocks are large and heavy—is to get the edges clean (*without the aid of the hammer and chipping knife*). The reason is, of course, that the heat is conducted away from the tinning to the body of the valve, or whatever it may be that is being wiped on to the pipe. And as it is not always practicable to heat the whole of the brasswork as is sometimes done with a hot iron, the heat produced by the solder has to be sufficient for the purpose. Now if a strip of paste paper is bound round the brass from the edge of the tinning to the

body of the valve, although it will not prevent the heat passing into the valve, it will, being to some extent a non-conductor, prevent the heat from the solder at the edge of the joint passing so quickly into the brass before the plumber has time to wipe the edge clean. If paper is not used, but only a coating of soil, the result is the solder hangs to the brass and sets almost instantly, making it very difficult and sometimes impossible to wipe a clean edge. The quality of the brass has often much to do with the working state of the solder. Brass being an alloy of copper and zinc, the cheaper kinds, especially those used for valves which have no surfaces ground together, are composed of a larger proportion of zinc than is generally the case in the manufacture of ground-in cocks. The consequence is, when brasswork is being wiped on, the solder is often used at a very high temperature with the object of heating the brasswork; the larger part of the solder is then poured on the brass, with the result that numerous particles of zinc are fused and carried away by the solder in the same manner as that already mentioned with regard to imperfect tinning. This reminds me of another argument against using solder too hot. Of course it is not to be supposed that there is the least probability of fusing the brass, because to do that would require about the mean temperature between the fusing points of copper and zinc, *viz.*, 2000° and 773° Fahr., and differing according to the relative proportions of the two metals composing the alloy. But as solder is often used at a temperature much above the fusing point of zinc, it has been proved by practice, beyond a doubt, that the continual pouring of very hot solder directly on the brasswork will release a certain amount of zinc, a small portion of which will spoil a large pot of solder and make it not only very difficult to wipe joints with, but very often absolutely useless. Therefore my contention is that if paste paper were used, not only would it be much

easier to get the edge of the brass clean, but there would be no necessity to pour the solder on so hot at the risk of poisoning the solder, and melting the lead pipe, as is frequently the case when those who are not well practised in the craft are making joints. And as the objection to the using of overheated solder is applicable in an equal, if not greater, degree to underhand as it is to upright joints, it is well to take all precautions that are favourable to this very

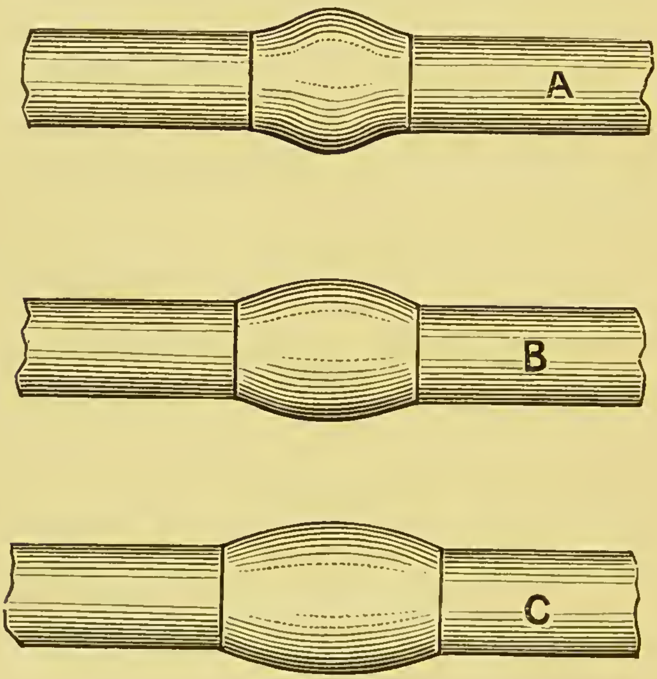


Fig. 89.

important matter. It is sometimes difficult to make the paste paper stick to the brasswork owing to the shape of the valve or union, and as brown paper is the best to use for this purpose, it will not conform to the shape required. But if the paper is cut into long narrow strips and well soaked in water before being pasted, it can be wound round the brasswork to any shape required, as shown at Fig. 88, on a tapered cap and lining.

The paper will also keep the nut back tight to the shoulder when the joint is being made, thus dispensing with the elaborate system of wedges and string that is often adopted to fix the nut. The fixing for underhand joints is very simple; this is shown at Fig. 87. All that is required are three blocks of wood or bricks, a stick about eighteen inches long driven tight into the brasswork, a strong pair of compasses, and something heavy laid on the stick to keep the brasswork steady, or else a piece of strong string and two clout nails to tie it to the bench as shown. The question of preparing the end of the pipe has been dealt with already, but it will be advisable to mention the importance of making sure that the brasswork is well fitted into the end of the pipe so that no solder will get through the socket, or the result will be a solid joint. But do not by any means close up the edge of the pipe; the inside edge should be shaved about a quarter of an inch and left open to allow the solder to sweat in the space.

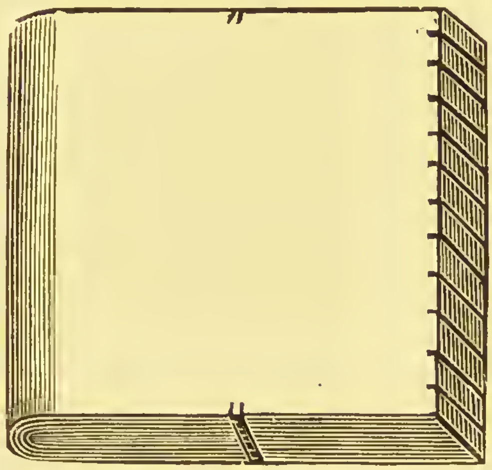

FIG. 90.

Now in the wiping of underhand joints, one of the greatest mistakes that are generally made is to use thin cloths. It is very difficult, if not impossible, according to my experience, to make a good shaped joint with a thin cloth. The two joints A and B shown at Fig. 89 represent the kind of shapes that are, as a rule, made with the aid of thin cloths. By thin cloths I mean about five thicknesses of perhaps thin moleskin or fustian.

Tick is nearly out of date now; it is not nearly so suitable for cloths as moleskin ; it is too flimsy, and makes such a rough surface to the joint compared with the other kind of material. Another objection to thin cloths is their liability to get hot so quickly. Before the joint is finished, it is almost impossible to hold the cloth for the intense heat; this is undoubtedly one cause of badly-made joints. A cloth for, say, an inch underhand joint should be made of about eight thicknesses of good moleskin. The width should be an inch longer than the joint, and the length about the same, or if anything a trifle longer. It is not a good plan to fold the cloth out of one piece of material, because where the folds are at the sides, it is difficult to make it bend as it is required when in use. The best plan is to cut the moleskin into pieces, twice the length, and exactly the same width as the cloth when it is finished. These should be folded once, and sewn together at the edge with thread. Fig. 90 is a sketch of a cloth of this kind. Those who are used to using thin cloths would no doubt find it rather awkward to use thicker ones at first, but with practice they will be found to be much more convenient to use, and turn out a better-shaped joint, such, for instance, as that shown at Fig. 89 c. But thin ones after they are hot get out of shape and give too much to the shape of the fingers; the result is, the bottom of the joint is often wiped off, or the edges wiped bare, as shown at Fig. 89. Another advantage of thick cloths is, the joints can be made so much lighter ; this is an important consideration, because it is not only economical, but joints, in my opinion, look much neater when they are wiped light than they do when the solder is left on to such unreasonable thicknesses. It does not necessarily follow because a large amount of solder is on a joint that it is any more sound or stronger than a lightly wiped one; that is, of course, if the joint is made with a reasonable amount of solder.

Providing a joint is properly prepared and fitted, the solder at the centre should be about half as thick again as the pipe it is wiped on. If this rule be carried out, the amount of solder on joints would be regulated according to the weight of the pipes, as it should be in all cases. The following table gives the approximate lengths of joints for various size pipes, and the dimensions and thickness of cloths suitable for underhand and upright joints.

| Dia. of Pipe. | Length of Joint. | Size of Cloth. | | Thickness. |
|---|---|---|---|---|
| | | Underhand. | Upright. | |
| Inches. | Inches. | Inches. | Inches. | |
| ½ | 2¾ | 4 × 3½ | 4 × 2½ | 6 |
| ¾ | 3 | 4½ × 4 | 4½ × 3 | 8 |
| 1 | 3¼ | ,, ,, | ,, ,, | ,, |
| 1¼ | 3⅜ | ,, ,, | ,, ,, | ,, |
| 1½ | 3½ | 4¾ × 4¼ | 4¾ × 3¼ | ,, |
| 2 | 3⅝ | ,, ,, | ,, ,, | ,, |
| 2½ | 3¾ | ,, ,, | ,, ,, | ,, |
| 3 | 3¾ | 5 × 4½ | 5 × 3½ | 10 |
| 3½ | 3¾ | ,, ,, | ,, ,, | ,, |
| 4 | 3⅞ | 6 × 5 | ,, ,, | ,, |
| 5 | 4 | ,, ,, | 5½ × 3½ | ,, |
| 6 | 4 | 8 × 7 | ,, ,, | ,, |

# CHAPTER XVIII.

## USE OF "TOUCH" IN SOLDERING.

IN the previous chapter we considered the preparation, fixing, and the kind of cloth most suitable for wiping an underhand joint to brass and lead. But in the tinning of the brasswork, and also in a very simple thing that is always necessary to be done before the solder is applied to the shaved surface of the pipe, there is a little chemical problem involved, upon which there is generally either a great deal of misunderstanding, or else it is considered a matter too far above the comprehension of the minds of plumbers—at least, of those who consider that a technical knowledge of their trade and the chemical action of the metals they use is superfluous, if not useless. Therefore it will perhaps be well to make a few remarks on the subject before we proceed further with the more practical matters.

A stranger to plumbing, while watching a plumber making joints, will probably hear him ask his mate for the "touch". "What do you mean by 'touch'?" asked one of a plumber when he heard the mysterious term mentioned; but before there was time for an answer the mate had rubbed it on the shaved surface of the pipe, and also on the wiping cloth. On examining the substance in question, the stranger to the art and craft of plumbing exclaimed: "Oh! it is only a common tallow candle after all! What do you rub it on the pipe for? Does it make the solder stick, or is it to make the solder work easy?"

The answer that is generally given to this question is,

that it is to make the solder tin to the pipe; but why it is necessary, or how the desired effect is produced, is very seldom forthcoming from the craftsman. Of course, it would be difficult, if not impossible, to give a full and absolutely correct explanation of the chemical action that takes place in such terms as are permissible to one who claims no higher title than a plumber. Therefore, by avoiding technical terms as much as possible, we will try to explain the action as follows :—

Nearly all metals, when their surfaces are exposed to the atmosphere, are affected by the moisture and the oxygen contained therein; the greater the amount of water in the air, the quicker is the action on the surface of the metal, because air entirely devoid of moisture has no action on most metals, except at very high temperatures. But as an absolutely dry atmosphere is impossible under ordinary circumstances, it naturally follows that, whenever the surfaces of metals are cleaned by scraping, filing, or otherwise, the exposed parts quickly tarnish or lose their brightness. This is caused by the metal absorbing the moisture and the oxygen from the atmosphere in such a manner as to convert the surface of the metal into an oxide—in the case of lead it is oxide of lead, or what is commonly called corrosion, and in that of iron, oxide of iron or rust. The baser kinds of metals absorb oxygen and other gases much more rapidly than the finer kinds, such as silver, gold, and platinum. Lead, being one of the baser kinds of metals, is therefore affected very quickly, whether it is exposed to damp air or water.

When heat is applied to lead the oxidising action takes place more rapidly; in fact, if it is heated to a temperature just below melting point in a current of air for a sufficient length of time it will become oxidised and converted into what is chemically termed protoxide of lead, or massicot.

And if under similar conditions it is raised to a temperature considerably above melting point, the oxide is called litharge.

The reason why lead oxidises more quickly when it is heated, is because heat is said to be opposed to the force of cohesive attraction and consequently produces molecular motion. In other words, all metals being composed of minute particles, which are held together by what is called cohesive attraction, heat expands the metal and throws apart the particles. If the heat is increased to a temperature of 612° Fahr., the attractive force becomes so weakened as to allow the particles to fall away from the mass, and ultimately the metal is said to be fused or melted.

It is obvious, therefore, that as soon as heat is applied, in however small a degree, the metal is in such a condition as to be favourable to the absorption of gases that it has an affinity for, owing to the interstices or pores between the particles becoming enlarged, and the particles also being comparatively loose and easily acted upon by the oxygen. The result of this action of course varies according to circumstances, whether it be the condition of the atmosphere, the degree of heat applied, or the quality of the metal. But in any case a coating of oxide will form on the surface of the metal if proper means are not taken either to prevent it, or, in cases when it is impossible to prevent its formation, to dissolve it. In the case of wiping joints to lead, means have been used to prevent this oxide forming to any great extent on the surface.

Now to solder two pieces of metal together, an alloy must necessarily be formed of the solder and the surfaces of the metals to be joined. The sticking or simply adhering of the solder to the metals, as is commonly supposed to take place, is not soldering, although there is plenty of this sort of thing done by professed plumbers, and left for soldering. This is much to be regretted, because in the principle of a

properly soldered joint lies, to a large extent, the great superiority and security of good plumbing work. Solder, then, on a joint should hold to the metals by the attraction of cohesion, or in other words, it should be part and parcel of the metal it is joined to, and become alloyed to it by the partial fusion of the surface of the metal upon which it is wiped to form the joint. Probably it is not quite correct to say that the partial fusion of the surface takes place in all cases, especially with regard to the harder metals, such as brass and copper; but theoretically, there is no doubt this view may be taken in the case of the hard metals, and as regards lead and other soft metals, that the partial fusion of the surface practically takes place, there can be no doubt. In fact, as we have already shown in a previous chapter, this melting of the surface of the lead often occurs more than it should, as the result of carelessness and unskilfulness on the part of the plumber, either by using the solder too hot, or by pouring it too much on one place. It is, of course, not at all necessary that any part of the surface of the metals to be soldered should be removed by what has been termed partial fusion, or in any way disturbed, except that by the application of the heated solder, the particles of the metal are to a certain extent separated from each other, which enables the tin in the solder to penetrate into the interstices or spaces between the particles, and thus thoroughly alloying the solder with the lead. This shows the value and importance of tin in the manufacture of solders; lead of itself would not have the same effect, but would have to be treated in quite a different manner, *viz.*, by using means for actually fusing or melting the surface of the lead that it has to be joined to. This form of soldering is called autogenous soldering or burning, of which we shall have something to say later on.

We have seen that as soon as the ends of a pipe have

been shaved and the brightness of the metal exposed, it soon becomes dull and tarnished by the coating of oxide formed by the action of the atmosphere; we therefore cover the exposed surface with grease, with the object of arresting the action of the oxygen in the atmosphere. But it will be well to remember that it is all but impossible to entirely prevent this action, because as soon as the shavehook has taken a shaving off, the action had begun. Consequently, after all it is a matter of degree. This is made evident by the fact

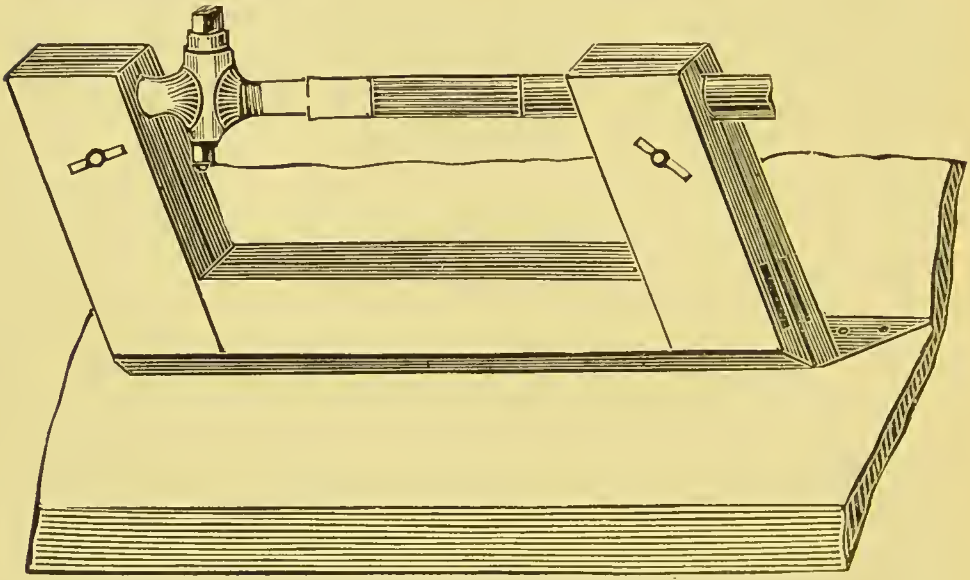

FIG. 91.

that it is possible to leave the shaved part exposed for several hours or even days before it is "touched," so long as it does not get covered with dirt or become wet by a damp atmosphere, or otherwise, showing that a slight coating of oxide is immaterial. But the most important thing is to apply the touch before the solder is poured on; not that it is advisable to leave the touching until the joint is wiped. As a matter of course, the sooner it is done the better, but inasmuch as heat, when brought in contact with the lead, facilitates the formation of oxide, it follows that if the

solder is poured on before the touch is applied, the heat of the solder will cause the surface of the lead to oxidise and prevent, or at any rate hinder, what is technically termed the tinning. Some plumbers say that lead will tin without touch being applied. That is, of course, possible if the solder is used too hot; but it must be recognised that, from the very fact that the cloth is saturated with touch, an explanation is not at all difficult. Let any one try to solder a piece of lead with a copper-bit without touch or a flux of any kind, he will soon see what a difficulty it is, if not an

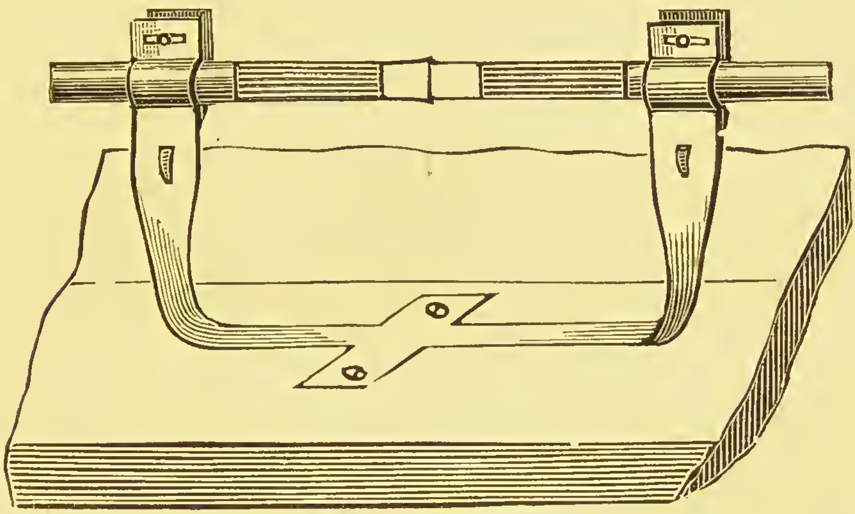

FIG. 92.

impossibility to make the solder tin. However, whether it is possible or not, one thing is certain, that if the touch is used, the tinning is done safely and without any difficulty; and as it admits of a reasonable explanation—as we have tried to show—its advantages are unquestionable. When tinning brass it is necessary to use resin instead of a simple fat substance. The reason why touch is not suitable for tinning brass is because a greater heat is required for this purpose, and the consequence is the touch evaporates before the brass is hot enough to take the tin.

Therefore a substance such as resin, or something of a resinous nature, is required to withstand the extra heat and resist evaporation until the whole of the surface is tinned. There are some kinds of composite candle that answer this purpose very well, and sometimes better than resin.

Tallow and resin are sometimes referred to as fluxes, under the same head as chloride of zinc, hydrochloric acid, sulphur, borax, etc.; but although they are all used for a similar purpose, their action is entirely different. The former are used to prevent oxidation, but the latter are solvents for dissolving the oxide that has formed either before or at the time the tinning is in progress. Therefore, if the one class are fluxes,* the word is not quite applicable to the other.

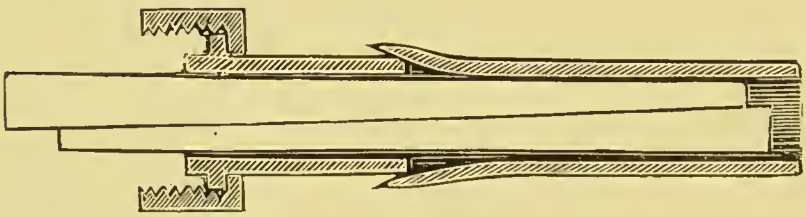

FIG. 93.

A good illustration of the different actions is given in tinning the face of a copper-bit. If resin is used it will be found that the bit must not be very hot, and then it has to be rubbed on the tinning plate very quickly after the face has been filed; but if it is delayed long enough to allow the surface to oxidise it is useless to rub it on the tinning plate for any length of time. If chloride of zinc (killed spirits of salts) or sal-ammoniac is used, no such hurry is necessary, especially with the latter, because they are strong solvents, and will dissolve a coating of oxide if it has formed on the

* The word flux is here used in its commonly accepted meaning. The true definition of the word is flowing, or the act of flowing; it is derived from the Latin word "fluxus".

face. Although it is generally necessary to file the bit when using chloride of zinc, the sal-ammoniac will very often enable the bit to tin without being filed even when it is red hot. We have digressed somewhat from the subject of underhand joint-wiping, although we have not exhausted all that can be said concerning the use of touch, and shall have more to say about it further on.

Before proceeding with the wiping of joints, a few more examples of fixing will perhaps be interesting. Fig. 91 is a sketch of a wooden joint-fixer; it is made in two separate pieces, and hinged at the bottom edges; semicircular or V-shaped notches are cut near the top so that the pipe or brass

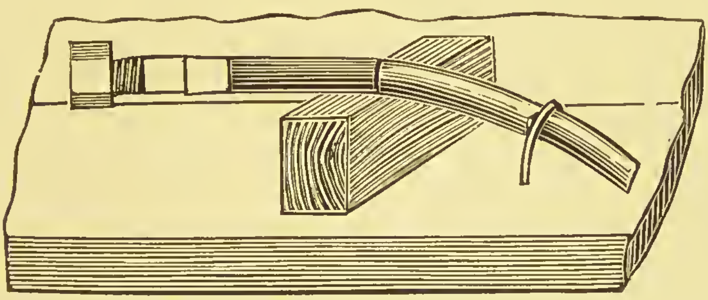

FIG. 94.

work can be held firmly; the pieces are screwed up by means of the bolts and fly nuts. The bottom of the fixer can be cut to an angle so that the top leans forward, thus allowing room under the joint for something to catch the surplus solder; angle irons can be fixed on the lower back edge so that the fixer can be screwed to the bench.

Fig. 92 is a sketch of another kind made of flat iron bar. There can be no doubt that if these fixers are used at all, the wooden one is to be preferred to the iron, because the wooden fixer will not only prevent the pipe from being bruised where it is screwed up, but it is not so likely to form a conductor of heat as the iron one is, especially when

brass valves or cocks are fixed in them. I have no particular fancy for these machines, but they are undoubtedly very useful for bench work and in other convenient places. Fig. 93 is another method for fixing a cap and lining to a lead pipe. It is very simple and makes a firm and solid fixing for this kind of brasswork, especially if the brasswork has to be wiped on short pieces of pipe, as in that case very little fixing is required, as shown at Fig. 94. All that is wanted is one brick or a block of wood, and a strong pair of compasses, or a long hook driven into the bench to keep the pipe steady. If it is in some place where a bench cannot be used, it can be fixed on the floor by laying a heavy weight on the pipe instead of fastening it with a hook.

Plumbers generally have need of a very broad back to bear all the many charges that are brought against them. No matter where they go they are very fortunate if they do not very soon offend either one trade or the other.

Some trades are waiting for them to commence, and others cannot get on while the plumbers are there. Floors have to be taken up and holes have to be cut that ought to have been done before, so the plumber is told; but at what time previous it is often difficult to say. Very probably the time should have been a considerable period before a plumber was consulted, or perhaps thought of. Plumbing is quite an after-thought with many people. Now one of the most serious faults found with plumbers is that they have apparently an intense delight in cutting away plaster, brick-work, and woodwork, much to the annoyance of foremen and clerks of works. Whether these charges are true or not is a question of serious dispute, and will probably not be settled until the general foremen and others concerned have become plumbers, and have tried to do the work themselves. But until that time it is a matter of impossibility to put an end to the controversy, because the two parties will look at

the affair from two entirely different points of view. This is inevitable while one has to do the work that he can do, and the others look on at what they cannot do, and therefore do not realise the necessities and difficulties of plumbers' work. One of the principal matters that give rise to these misunderstandings is the cutting away and fixings used for the purpose of holding pipes while the joints are made. And while defending plumbers, to a large extent, against the charge of wholesale and wilful destruction, yet one cannot help recognising the fact that there is a large amount of carelessness exercised and much damage done by some men, which, with a little consideration, might be avoided. Whatever means are used for fixing joints, whether by the aid of fixers, as illustrated in the previous chapter, or by such means as are shown at Figs. 95 and 96, great care should be taken to get the pipes that are to be soldered together firm and rigid. Of course it is not at all necessary that the fixings should be strong enough to bear one's weight, however light the plumber may be ; yet, to see some fix a joint one would think they were making a scaffold to work on, instead of providing means to hold a pipe while a joint is wiped on it with heated solder, which, if manipulated in a proper manner, should need but little strain to cause vibration. As a matter of fact, the less pressure that is brought to bear on the joint when it is being wiped the better, because the solder should be left at such a heat as to require but little pressure when the wiping is being finished.

But it must be admitted that these remarks apply principally to favourable circumstances, especially with regard to the condition of the solder. For it is unfortunately not always the case that the solder is in a proper working state. Solder is rather a delicate material, and is subject, or one might say predisposed, to various disorders, either through being short of its vital ingredient, tin, or by

being poisoned with zinc or other matters foreign to it. It consequently follows that, in some instances, the solder requires rather rougher handling than it would do if it was in a state of perfection.

It also frequently happens that joints have to be wiped in very awkward positions, which make it almost impossible to work the solder in such a manner as one might wish; therefore a joint that has to be made under unfavourable conditions would require more careful fixing than one that was easy to get at, and good solder at hand to wipe it with. Some plumbers will make joints while their mate holds the pipe, if they only have something to rest the pipe on or against to keep it steady. In such cases as these the joints should be wiped quickly. There is, as I have already remarked, such a vast difference in plumbers; while one man is fixing his joint or pouring the solder on, another will have made his joint and cooled it with a small quantity of water.

When making joints on pipes that are fixed after the plastering is finished, nothing is more vexing than to see several holes in the wall where chisels have been driven in, and when drawn out have broken away large pieces of plaster. In the case of lath and plaster partitions it is generally very difficult to get a good fixing just at the place where it is required; this leads to much damage being done to the surface in the process of finding the studs. In cases of this kind it is a good plan to fix the pipe as shown at Fig. 95. Get two pieces of timber long enough to reach from the floor to a few inches above the pipe. If the pipe is fixed in the angle of the ceiling it can of course be bent down low enough to get at the joint. The bottom ends of the timber should of course stand away from the wall, with the top ends resting against it. The top ends should also lean towards each other, so that they will have a tendency to hold the

ends of the pipe close together. The pipe can be fastened to the timbers either with pipe hooks or else tied with string. No other fixing will be required, either by driving anything in the wall or otherwise. This plan also provides easy means for fixing a board for catching the surplus solder, as shown in the sketch ; two fillets can be nailed on the sides of the timbers and a piece of board laid on them. When chisels are used for fixing, two are required for fixing this board, making additional holes in the plaster. Sometimes the mate holds a board or shovel up to catch the solder;

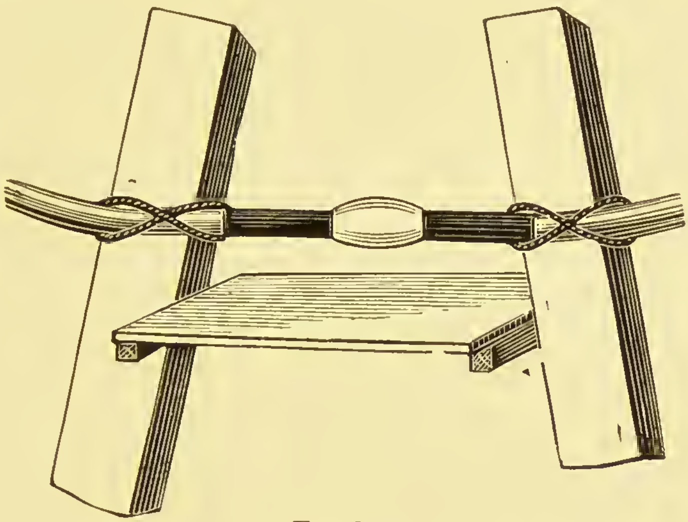

Fig. 95.

but this is often rather dangerous, as the solder is likely to splash in his eyes or otherwise fall on him. I have known some to hang the board from the fixing chisels, as shown at Fig. 96, by a piece of string. This plan is very well if the chisels are strong and fixed firm, but if one is not careful the weight of the solder will cause the pipe to be pulled down and break the joint before it is cooled. In the sketch, Fig. 96, a pipe is shown fixed to a brick wall; but if a wall is finished and pointed, it is better if possible to use the means shown at Fig. 95, or some other method with the object of avoiding damage to the wall.

It has been said of the American plumbers that they can fix pipes and wipe joints in a *drawing-room* without the furniture or carpet being removed, and so careful are they that after they are done no trace is left to show that plumbers have been working there. Whether American plumbers are more neat and careful than the English, as some say they are, I cannot say, but I certainly doubt the authenticity of the statement. Nevertheless plumbers cannot be too careful in the matter of cutting away and fixing, because they must necessarily do more in this respect

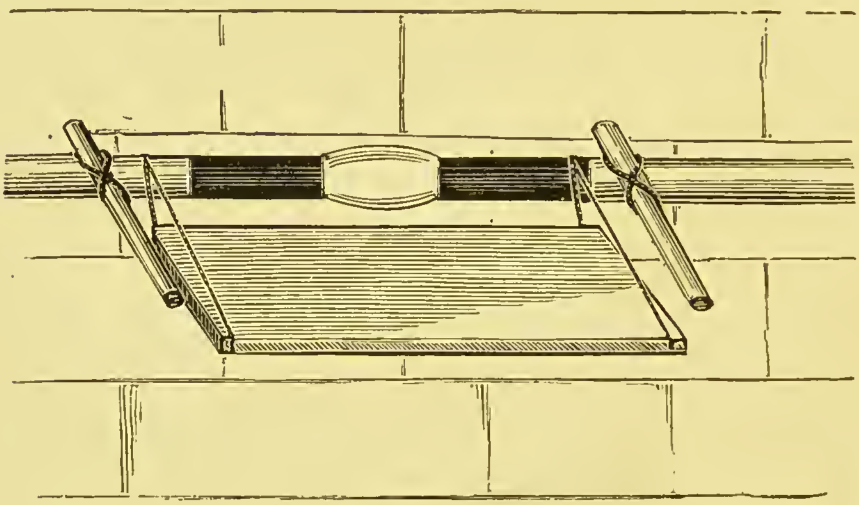

Fig. 96.

than most people think essential who know little or nothing about it. Therefore it is well to do all we can to cause as little friction with other trades as possible, whatever the peculiar circumstances of the case may be. If it should occur that a joint has to be made on a pipe passing across a ceiling, it is rather an awkward job to fix it, even supposing chisels are driven into the ceiling joist for the purpose. To avoid making holes in the ceiling, except those required for the pipe hooks, the joint can be fixed as shown at Fig. 97. Place a piece of clean board up to the ceiling and strut it

there with two pieces of timber, just long enough to fix tight between the floor and the piece of board. The pipe can be tied to the two upright struts, and a board can also be fixed to them for catching the solder; this plan makes a firm fixing and does no damage to the ceiling.

It seems almost unnecessary to say that it is not at all advisable to fix pipes across ceilings, as they look awkward and unsightly; but, of course, it is unavoidable sometimes, so that it is well to make the best of it if it should occur.

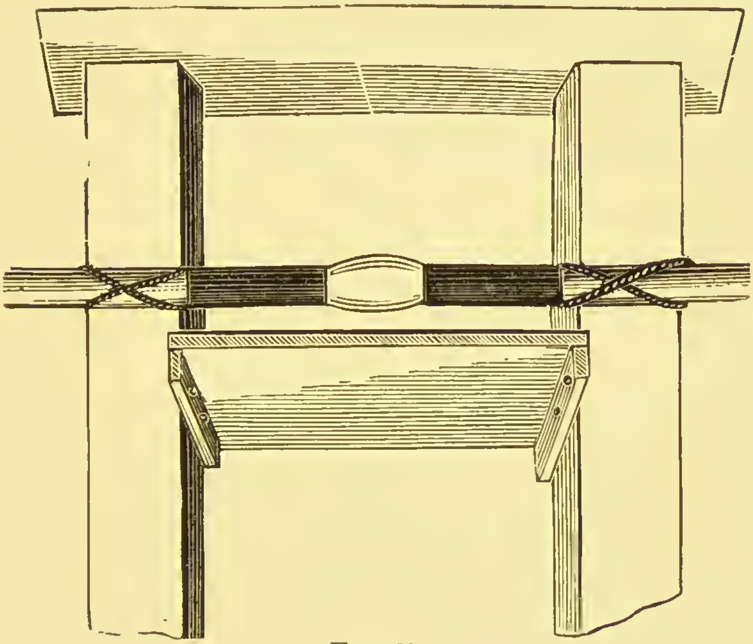

FIG. 97.

Now with regard to wiping underhand joints on small pipes, there are several hints that may be useful, and perhaps more important than that part of the subject that relates to fixings, although the latter is by no means a minor matter, considering the difficulties that it sometimes presents to the plumber.

In the first place see that the solder is not too hot, because in the case of underhand joints as well as those wiped upright this is a disadvantage.

The ladle should have a spout at the left hand side so that the solder can flow freely from it in a steady stream. Some plumbers have a hole through the spout of the ladle, about half an inch from the edge, as shown at Fig. 98, so that the solder can run through in a regular size stream.

I do not agree with this hole in the ladle, because as it is impossible in all cases to keep the solder at one regular heat it is necessary to pour on much quicker when the solder is getting cool than it is when it is first taken out of the pot; but if it has to run through a hole it will run quicker when it is hot and slower when it is at a lower temperature.

FIG. 98.

And if the solder is poured over the spout of a ladle with a hole in it, you get two streams of solder, one dropping on the joint and the other probably in your hand under the cloth; consequently I consider the hole useless, if not a decided drawback. Pouring the solder on a joint is undoubtedly one of the most important things in making an underhand joint, therefore it is the almost universal plan to hold the ladle in the right hand and the cloth in the left; not that the joint is always finished with the left hand, because, as a matter of fact, it is not by all plumbers, although as a general rule underhand joints are wiped and finished with the left hand. I do not know why, except that it is supposed to be the regulation style. There are some who think it unskilful to use their right hand to an underhand joint, yet they do not hesitate to use both to an upright or branch. In my opinion this order of things would be better if reversed, although there can be no doubt that the best way to learn to make good joints is to use both hands, either right or left,

according to circumstances. Many an awkward joint would be wiped with less exertion if one hand were used for one movement and the other hand for another. However, in most cases it is best to hold the cloth in the left hand when pouring on an underhand joint, because, as the solder requires pouring on carefully, one has more control over the right hand than the left.

With regard to holding the cloth, a common mistake with some is to let the cloth lie on their hand in such a manner as to have not the slightest control over it. One result is, that as soon as they make a start to draw the bottom solder up to the top of the joint, they drop the cloth and receive what they were trying to avoid, that is, a piece of hot solder in the middle of the palm of the hand.

It is therefore very important that the cloth should be held firmly by the thumb being pressed upon it tight; free use should also be made of the fingers to press the cloth to the solder either in the middle of the cloth or the edges, as the case may be.

Another hint that is necessary for many is, do not be afraid of being burnt. The fear of being burnt is the cause of many failures in joint-wiping. I have known several young men who, when they have been trying to wipe joints, concentrated all their attention on their hands, and seemed to be all the while measuring the distance between the stream of molten solder and their wrists. I knew one who, by-the-bye, desired to be more of a plumber by experience than by practice, who used to wear gloves when he practised wiping joints, for fear he should get a practical trade mark on his hand.

It is generally the case that the young man who resolves to be a plumber and to wipe joints, whether he burns himself or not, is the man to find joint-wiping not so difficult as it seems to be at the first start. Not that it appears

difficult when others are doing it, especially when it is being done by an expert hand. There are but few things that look easier to the uninitiated than the wiping of a plumber's joint, and many have thought they could do it without tuition, with the result that they have "burnt their fingers over it," both figuratively and literally, and resolved never to try again.

# CHAPTER XIX.

## UNDERHAND JOINTS.

THERE are some things of which it can be said (to use a common saying) that they are "quicker said than done". But there are also many matters to which this remark is not applicable, and among them, one might safely say, is joint-wiping.

The ways and styles of doing plumbing work are so numerous, especially with regard to joint-wiping, and the different methods of fixing, both necessary and fanciful, according to the nature of the work, or the ideas of the plumber, are so many and varied, that it would be possible to go on to almost any length describing one's experience and the experiences of others as relates to even one branch of the subject, because the experiences of two men—even supposing they have learned their trade at the same shop and have worked at similar jobs for years—are not necessarily the same, nor anything like identical.

One plumber would get over a difficult job in quite a different manner to another. Even in ordinary work the styles and methods differ, not only according to the countries in which the work is done, but in nearly every country there are different ways of carrying out plumbers' work, some good, others bad, and some may be described as indifferent, all of which seem to be governed by some (and in many cases mysterious) local circumstances. I use the word mysterious, because in several counties of England it has been the custom to discard wiped joints as much as possible, and to

substitute copper-bit joints in their stead, even on large pipes. Yet the very joints that are the most difficult and often impossible to make with a copper-bit, namely, horizontal or underhand joints, and, consequently, generally have to be wiped, are just the joints that are to them the most difficult. I do not mean to say that this is the case in all places where the copper-bit is so frequently used, but I have had the opportunity of observing in many instances that those who have been used to the copper-bit style of plumbing are very poor underhand joint-wipers until they have had a few years' practice with the better classes of plumbing work.

One of the reasons for the inability to make underhand joints with ease and style is, in my opinion, owing to the lack of a general knowledge of the nature, and the possibilities of the use, of wiping, or plumbers' solder. When a man by considerable experience and practice has gained a thorough understanding of what can be done with solder, and can (to use a common expression) "play with it," it matters little to him what kind of joint it is, or what position it is placed in, he can wipe it without any effort beyond that which is necessary as a matter of course. But, on the other hand, take the case of a plumber who is among that number who seem as if they never will master the art of soldering. On the bench, or some other equally convenient place, he will probably turn out a fairly good joint; but put him to wipe a joint in a less favourable position, which may not be particularly awkward, but either too high or too low, or not quite perpendicular or horizontal, the result will be a mere botch, if not an absolute failure to wipe the joint at all. Therefore what is necessary is not only to know how to make a joint, but to have a thorough practical and experimental knowledge of what solder can be made to do, under any conditions, whether they are favourable or otherwise. It would be well at this point to remind young plumbers, or

those who are learning the trade, of the delusion they often are subject to, and that is, they frequently regard all the other branches of the trade with comparative indifference, and concentrate their energies on learning to make one kind of joint, with the idea that, as soon as they are able to accomplish such a feat of skill, they can call themselves plumbers without the slightest hesitation. In fact, some want to make a joint, and use the tools, before they have acquired the necessary abilities for waiting on the plumber they are supposed to assist, even in so small a matter as cleaning an iron or heating the solder. It is a great mistake in plumbing, as it is in other trades, to want to begin too high up the ladder. As far as my observation has served me, there can be no doubt that the best mate or labourer makes the best plumber, and the mate that cleans an iron best will almost invariably make the best joint.

FIG. 99.

There is a tendency, in these days, to turn men into machines, by dividing labour to such an extent as to make them skilful in only one branch of their trade. In some trades men are made to do one particular part of the work so continually that if they were required to execute the work in another division of the same trade it would seem a new trade to them, and take them some time to get used to it. The constant manipulation of one kind of work produces such a mechanical action in workmen that when they attempt another branch they find their hands require to be trained over again. Now, this kind of thing should be avoided as much as possible in plumbing, because, if not, just the same difficulty will occur, as, in fact, it does occur in numerous instances.

There are many plumbers who habit themselves, in the case of underhand joints, to make them one particular length under all circumstances, or to use one size cloth to each kind of pipe, no matter in what position it has to be used. They cannot make the joint if they have not a certain space between the bottom of the joint and the floor, or whatever the surface is beneath it. In short, they want to make every joint on the bench, or in some place where there is not the slightest difficulty or drawback.

It has been my intention to show, in the foregoing remarks, that what follows with regard to the actual wiping of underhand joints is not written with the idea that all joints should, or can be, made in exactly the same manner, nor that because one may make a joint in a different way to another, that the one is wrong and the other right. They may both be right, although they each go a different way about it; but the man who knows both or more methods of making a joint has the greatest advantage.

When pouring the solder on a joint it is best to commence pouring on the soiled surface of the pipe, especially if the solder is rather hotter than it should be. The cloth should follow the stream of solder backwards and forwards, and catch the surplus. As soon as the cloth has in it as much as it will hold, this solder should be brought to the top of the pipe. When pouring on the shaved part of the pipe it is important to avoid pouring on the bare shaving as much as possible. It is much the best way to draw the surplus solder to the top of the shaving, and to pour on to that only. As soon as it falls down, either stop pouring, or else pour on the soiling until the lower solder is brought to the top again. By this constant movement of the solder round the joint a good heat will be produced without the probability of burning a hole in the pipe, and making a solid joint something like Fig. 99, which is a sketch of one I saw not long ago. In the

case of small joints there is not the difficulty in getting a good heat up underneath as there is with large joints, although the soiling on small joints should be five or six inches long each end of the joint, so that the solder can be poured along the pipe a sufficient distance to enable the joint to have as much heat near it as is reasonable. If the pipe is not well warmed each side of the joint with the solder from the ladle, the result is the heat in the solder that is to form the joint is very quickly conducted away by the cold pipe, and therefore makes it difficult to get the edges of the joint clean.

When the solder on the joint is at such a heat as to make

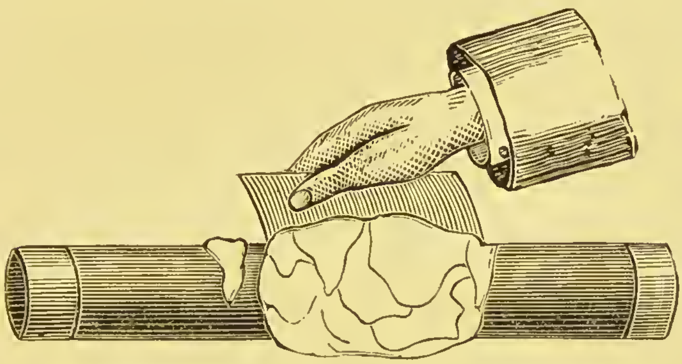

Fig. 100.

it difficult to keep it on the pipe, it should be patted round with the cloth roughly, and the surplus solder on the edges wiped off. The cloth should now be taken in the right hand, as shown at Fig. 100, and the wiping commenced at the back of the joint as shown. Drawing the cloth upwards, the forefinger should be used first to clean the edge nearest to it, after which the little finger should be pressed to clean the other edge. As soon as the edges are clean, *and not before*, the body of the joint can be formed with the middle of the cloth, as far as it is shown at Fig. 102. Now take the cloth in the other hand, and pushing the surplus solder downwards, clean the outside edges with the fore and little fingers as

before described. The formation of the joint with the left hand, as shown at Fig. 101, can be continued until it reaches where the joint was commenced with the right hand. If at this point there is a much larger quantity of solder than is required, it should be drawn off at one side. Now take the cloth in the middle of the right hand, pressing equally with each finger so that the cloth touches the whole length of the joint; wipe it round as far as convenient with the right hand, then change it quickly to the left hand, and continue the movement round under the joint to the other side. Sometimes it is necessary to wipe round the joint in this way two or three times before it is smooth and clean, but

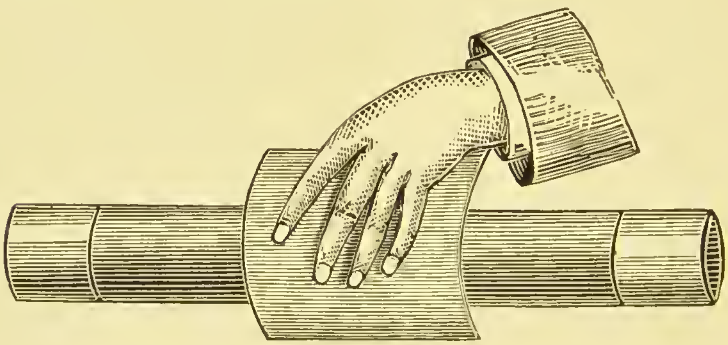

Fig. 101.

it is much the best way to avoid wiping the surface more than is absolutely necessary. As I have remarked before, with regard to upright joints, the sooner a joint is left alone after it is formed the better, both for appearance and reliability.

Underhand joints are found to sweat to a far greater extent than those made upright. .The two kinds of joints can be made from one pot of solder, and although the upright joints will be found to be perfectly sound and bright, those made underhand are often white and chalky, and sweat like water running through a sieve. This should certainly not be the case if the underhand joints are wiped

in a proper manner; the fact is, the joints, or at any rate those that sweat, are generally over-wiped.

Now the cause of this over-wiping, as I have termed it, is to be found to a large extent in the fact that far too many heats are used before the joint is completed. Although it is necessary to get up a good heat before the joint can be properly made, yet at the same time it is possible to get the pipe up to such a heat, and the solder into such a state, as to make it utterly impossible to make a joint to stand any considerable water pressure. The preparation of the joint may have been quite right, and probably the first heat would have made a good joint, but the continual pouring on of the solder, and the repeated wipings, and the almost melting heat of the pipe, seem to quite upset the usual working condition of the solder.

The effect produced is that the solder, by being disturbed so continually, gets into a state of disintegration; the lead in the solder seems to become, in a certain degree, crystallised, and looks like grains of sand, and not only looks like sand, but seems to work as if it was nothing better. The tin runs through the particles of lead to the bottom of the joint, and no sooner is it brought to the top, than it runs to the bottom again. The over-heated pipe, of course, assists in keeping the tin in a fluid state, although the lead particles have got into such a state as to be unaffected by the high temperature. The consequence is the bottom of the joint is constantly in a melted condition, while the upper part is nearly set, and no amount of wiping will make it anything better than a porous, chalky-looking bulb, which is neither use nor ornament.

It cannot be too often insisted upon that the first heat is always, under ordinary circumstances, whether it is for an upright or underhand joint, the best heat for a good joint. I have noticed that some plumbers have a habit of never

attempting to make an underhand joint with the first heat. Probably they think it necessary to get their hand in working order before they finish the joint off. But the worst of it is that it very often happens that the joint by the first heat, which was undoubtedly the most reliable, was also much better in appearance than the one that is left, after three or four heats have been used to accomplish it.

Now, in my opinion, this habitual practising style of making joints is a great mistake, because it gets a man into such a state that he has no confidence in his own abilities; he goes at his work in a half-hearted manner, and is never certain whether he can make a joint with the first, second, or third heat, or even if he can make it at all. The best plan, as I think, if a man wishes to become a thorough good joint-wiper, is to resolve to make the joint with the first heat, and if there should only be a slight defect, probably in shape or smoothness, to let it pass and "show the best side to London". If this plan is followed up for a few times, most plumbers would get themselves out of the bad habit of having several heats to a joint. It must be admitted, however, that there are certain exceptional cases where it is really a necessity to have more than one heat. But under ordinary circumstances, if this plan were carried out, it would be found that the joint would be made the first time as a matter of course.

FIG. 102.

It must, nevertheless, not be inferred that a careless style of joint-wiping should be encouraged, on the principle that all "sound work is good work". Far be it from me that I should write anything upon which could be placed such a construction. Unfortunately for the trade there has been, and is still, too much of the "near enough" style of plumbing being done, much to the discredit of the craft,

who, hitherto, have had to take the blame, whether the work has been executed by legitimate members of the trade, or only by botchers and tinkers. The registration of plumbers is calculated to weed out of the trade those who have no right to work at the trade either by virtue of their practical knowledge or experience. But notwithstanding examinations, both practical and theoretical, it is difficult to make some men do work in a careful manner if they have no direct interest in the result. It does not always follow that because a man has the necessary abilities, he will always use them to the best advantage.

Much depends upon the object in view, and this is often regulated by disposition or idiosyncrasies of the person doing the work. It is well, I think, sometimes to look below the surface in this superficial age, even in such a matter as the principles of plumbing. For instance, some plumbers, when they are wiping an underhand joint, will not leave it for finished until it has been made absolutely perfect both in size and shape—even the marks of the cloth have to be parallel and regular. I have known them to make it over as many as six times, and even more, notwithstanding the fact that half an hour afterwards it has been buried in earth or in some place where it could not possibly be seen. Some plumbers, who may justly be termed first-rate workmen, will do this although the joint when wiped the first time may have been so near perfect, that the fault, if any, would have been imperceptible to any person less skilled in the craft.

Men of this class seem to be actuated by the same spirit as the ancient artificers, who said that "the gods see everywhere". In the latter case it induced the craftsmen to execute their work in places where it could not be seen, but which was necessary to make it more complete, whereas in the former, no good is done, but rather much trouble is made of a trifle, with the result that much valuable time and

material are absolutely wasted, and encouragement is given to others to fuss about with the solder, instead of using it with determination.

There are, on the other hand, plumbers who are equally good workmen, who could, if they liked, do any plumbing job in a first-rate manner, but when left to themselves, seem to have no desire to make their work look clean and regular; anything will do if it is sound—that is the height of their ambition. "Sound work is good work," they say; anything more than that is considered so much nonsense. As to making an underhand joint more than once, they would think it a sign of unskilfulness on their part which could not be tolerated, at any rate as a regular practice. Now between the two extremes there is generally a middle course, which, as a rule, is undoubtedly the best to adopt.

Of course there are many persons who will tell you that it is impossible to be too careful, no matter what the job is; but this must to a very great extent depend upon circumstances.

As a case in point, the following incident came under my notice just recently. A young plumber having had a considerable amount of experience in a good class of work, had a large underhand joint to make in a very favourable position. With the first heat he wiped a very fair joint both in size and shape, and one that would be creditable to a man of more mature experience. But as the solder was rather fine, it was found that one of the bottom edges was rather thick, and a drop of tin had run to the bottom. So the plumber, not being satisfied, thought he would have another heat, and wipe it again. The result was, that instead of improving on the first, he made a worse job of the second, and still worse of the third—every subsequent heat proving more difficult to manage; and as the soiling became worn off, the pipe tinned beyond the shaving, and

made it more difficult by far to make the joint than it was at first. At last the plumber became disgusted with himself and the intended joint and threw his cloth at the joint in a very excited manner, at the same time expressing his regret that he did not leave well alone at the first heat. How long heat after heat would have been used, if another plumber had not made the joint, it is difficult to tell.

The cause of failure on the part of the young plumber was, in my opinion, through being over careful; it was not because he could not in ordinary cases make a good joint, for older men with much longer experience and practice get into a similar difficulty. It is because they get into such a habit of thinking they can make a better joint with the second heat, that the second leads to a third and so on, until, as I have already said, they lose all confidence in their own abilities, and are not certain whether they can make a joint or not. I thought it advisable to enlarge somewhat upon this part of the subject, because there seems to be a tendency in these days of improved styles of workmanship, at least among certain classes of plumbers, to become fussy and trifling over little unimportant matters, through the mistaken idea that such a course of action is essential to a good tradesman.

Now there is another question in connection with underhand joint-wiping that will perhaps be worth considering, although it may be thought by many to be out of date—I refer to the use of an iron. No doubt there may be found many who still use an iron for a small underhand joint, although the practice is fast dying out and is generally considered to be a whim not to be countenanced by modern joint-wipers. But why there should be so much prejudice against the use of an iron for small underhand joints, I am at a loss to find a sufficient reason. I do not say that it is really necessary to use irons for underhand joints, because,

as a matter of fact, if a joint is properly prepared and wiped as already described, an iron is not as a rule required; but it has been said, and it can be confirmed by all plumbers of any experience, that whereas an upright joint made from a certain pot of solder will be perfectly sound, if an underhand joint is made with the same solder it is very often found to sweat so much as to need wiping again. Now, if the underhand joint had been made with the aid of an iron it would be found equally as sound as the upright joint, and capable of withstanding quite as much pressure; simply because the iron enables the joint to be finished off before the solder has become so disturbed as to render it porous, and therefore in an unsound condition. The old-fashioned way of making underhand joints with an iron left no doubt in the mind with regard to their absolute reliability. When such a plan was adopted a coarse kind of solder could be used with perfect safety. The usual plan was to pour on the solder in the ordinary manner until a fair heat was raised; the solder was then melted off the joint into the cloth, and the iron rubbed round the pipe to well tin the shaved surface; after which the solder held in the cloth was well warmed with the iron and spread out on the cloth in the form of a flat cake. This was then

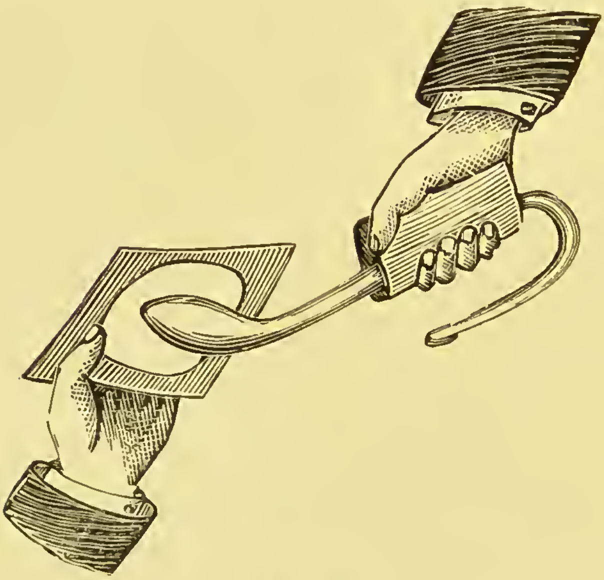

FIG. 103.

placed round the joint, the bottom being wiped first; each side was then wiped to the top, and the surplus solder drawn off at one end, very much in the same manner as an upright joint would be wiped if an iron were used. Figs. 103 and 104 will give an idea of the process I have endeavoured to describe.

Now it is not my intention by any means to advocate the return to this old-fashioned method of making underhand joints, although this and many other means used years ago are worth remembering, even if it is not thought necessary to imitate them, because the principle involved is sound and worthy of consideration by all plumbers, especially those

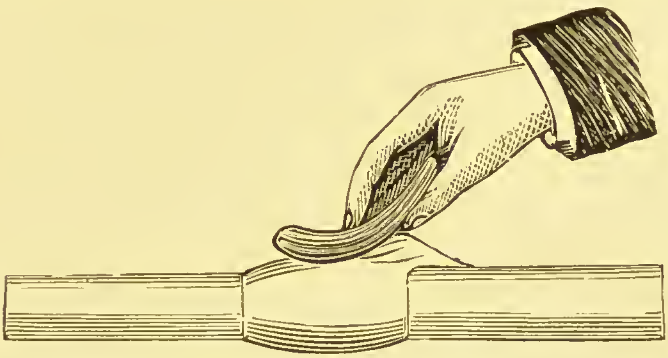

FIG. 104.

who have had no experience of the old styles of plumbing and have gained all their knowledge in the modern school, and particularly that class who may be termed the *anti-ironists*, if one may be permitted to coin a term to describe them.

It is thought by some that it would be utterly ridiculous to use an iron for an underhand joint, at least a small one, and they would hammer the surface of a sweating joint up to any extent, rather than use means to make it sound, if that means were the use of an iron. There are more than one or two leading men in the trade who still contend that all joints, without exception, should be made with the aid

of an iron, no matter what their size or shape, or in what position they may be placed. This may be carrying the principle rather too far; but it is not surprising to any who have had the charge of plumbing jobs, and have witnessed the struggles of many who are infected with the anti-iron craze, and seem to think because some plumbers can very well do without an iron that they are therefore forbidden to use one, notwithstanding their white chalky joints with thick edges, and the porous condition of the solder after numerous wipings.

We have already considered the reasons why and when an iron should be used, and my advice is, if an iron is not used, the solder should be so wiped as to leave the joint in a similar condition as it would be if an iron were used to

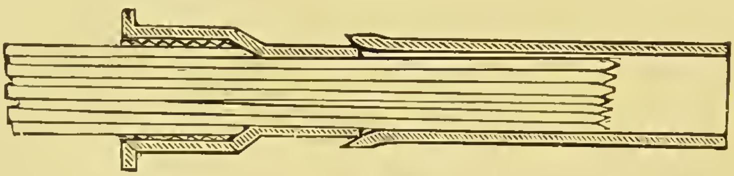

FIG. 105.

keep the solder at a good heat until the joint is finished. If the plumber cannot wipe it quick enough to leave it in that state then he should have an iron to assist him until he can.

There is another style that is very often adopted for making horizontal joints which cannot be termed underhand because all the wiping is done from the top—I refer to what are called rolled joints. When caps and linings, unions, or valves have to be wiped on to short pieces of pipe, the rolled joint is a very convenient method to make use of, and although it involves a considerable amount of wiping, as a rule, as the joint is rolled over and over again until it is finished, yet the continual wiping of the surface is not open to so much objection as it would be in the case of ordinary

underhand joints. Fig. 105 shows a brass boss fixed to a piece of pipe by means of what are generally called splints. These consist of a number of thin strips of wood which are driven through the brasswork into the pipe, until there is enough to hold the two parts firmly together while the joint is being made. The pipe is then placed across two blocks of wood, as shown at Fig. 106, so that the pipe can be rolled backwards and forwards either with the palm of the hand or by means of a short piece of board held in one hand and pressed on the pipe while it moves to and fro. It is not

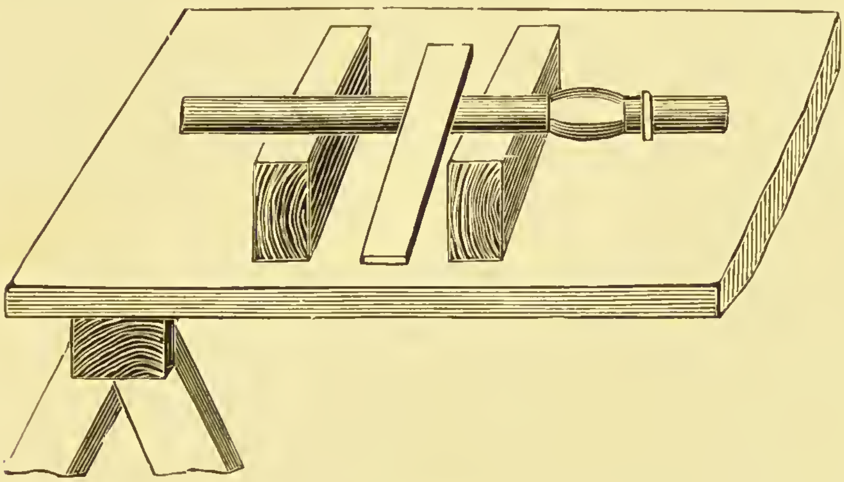

FIG. 106.

necessary to use an underhand cloth for these joints; a smaller cloth, the size that is generally used for upright joints, is quite large enough for the purpose.

Great care must be taken to fix the brasswork firmly to the pipe, or the result will be a broken joint. The fixing shown at Fig. 93 in a previous chapter is a very good substitute for the splints described above, and when the bore of the brasswork is as large as the pipe, a solid stick driven in will answer the purpose very well.

After the joint is properly prepared the left hand may be used to roll the pipe while the solder is carefully poured on.

The solder should not be very hot, but at rather a lower temperature than it would be used to an ordinary joint, because if the solder is very hot it is a difficult matter to get a body of it, sufficient to make the joint, to adhere to the pipe.

This difficulty is avoided by some plumbers by placing a weight of some kind on the pipe while they pour on the joint, while it is stationary, in the ordinary manner. After they have partly formed the joint they finish it by means of the rolling movement.

The cloth is held in such a position at the top of the joint as to mould the joint each time the pipe is rolled from the

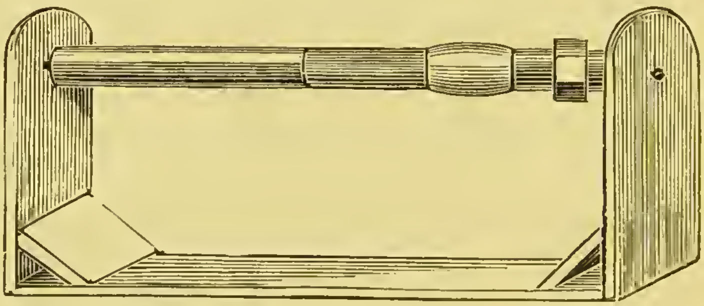

Fig. 107.

plumber. When the pipe is rolled back the cloth is lifted off the joint and brought down again when it is rolled away, so that the wiping only takes place in one direction. Any one not used to this style of wiping joints will find it rather awkward at first; but after considerable practice it is very simple, and turns out some nice-shaped joints. A much easier method is to turn the joints on centres, as if they were in a lathe. A rough arrangement is shown at Fig. 107, constructed with wood; the two centres are formed with stout screws, the ends being filed to a shape similar to a lathe centre. I have said that joints made in this way are not open to the same objections as those wiped underhand. The principal reason is this—that whereas the tin in a joint in a

fixed position will have a tendency to run to the bottom and drain out of the joint, the action is quite different in a rolled joint, because the continual rolling causes the tin either to become equally distributed or else to run to the centre round the pipe where it is most needed.

In the case of the solder being coarse and likely to produce a "sweating" joint, it is a good plan to "over-cast it," as it is called. The term is not a good one because it is apt to be confounded with the old style of "over-casting" with the iron. A better term would be "over-wiping" or "solder-washing," because the process consists of washing over the joint after it is made with a ladle or two of solder which is nearly set and wiping it clean off with the cloth—similar to that described for upright joints at page 144. The result seems to be that the porous surface of the joint absorbs the tin from the second portion of solder, causing it to assume a very bright surface which may generally be considered non-porous. There are only a comparatively few plumbers that ever practise the rolling method of making joints; it is principally adopted by plumbers employed by firms who manufacture sanitary fittings, many of which are sent out with the connecting unions wiped to short pieces of pipe. When this is the case it is an inducement to plumbers to roll the joints, instead of wiping them upright or underhand in the ordinary way. In general plumbing it does not often happen that several short pieces of pipe with unions attached are required; it is only in the case of a range of lavatories or urinals and the like that short pieces of service are wanted. There is not, in my opinion, much that can be said with regard to any particular advantage that is to be gained by rolling joints, excepting the probability of the joints being more reliable than they would be if they were improperly wiped underhand. For my part I consider a good joint-wiper would prepare and wipe joints underhand

much quicker and quite as good as they could be by rolling them. There are some plumbers, undoubtedly, who think they cannot be made so symmetrical and true by the ordinary underhand style as they can by being rolled, but this is assuredly a mistake, for there are plenty of joints wiped underhand quite as even and true as they could be made if they were rolled. As a matter of fact, if a plumber cannot make an underhand joint absolutely true, so that it will stand the test of measurement with calipers, he, in my opinion, has something yet to learn, and requires considerably more practice in underhand joint-wiping. Of course one does not mean to say that joints can be made so exactly in all cases, nor is it at all necessary in every case to be so particular as to their exact form and symmetry, because there are some instances where it would be all but impossible to make joints to perfection. But, nevertheless, it should be the aim of every young man in the trade to attain the highest proficiency possible in this matter of joint-wiping, as it is undoubtedly one of the most important branches of the trade.

What looks better in a plumbing job than to see the joints well wiped, well proportioned, and clean? The arrangement of the pipes may be inconvenient, and may look awkward, through circumstances over which the plumber, perhaps, has no control. But if the joints are properly made, and are bright and clean, they quite make up for all other drawbacks, and as far as appearance is concerned, they put the other parts of the work, with its unavoidable defects, into the background. Now, although, as I have already stated, the rolled joint method is very convenient when several joints of the kind are required, yet, as this kind of joint is never absolutely necessary, but is rather done for choice, or through the inability of the plumber to make them satisfactorily underhand, it is much the best plan to use oneself to the methods that are usually found necessary.

If a plumber wishes to become a proficient underhand joint-wiper, it cannot be advisable to wipe joints in a manner altogether different to that required in ordinary practice, because if he is so placed as to be able to do so to any great extent, he will find it rather difficult to wipe joints in such positions as are fixed and cannot be altered to suit the abilities of the plumber. Therefore, while fully recognising the reliability of rolled joints, and some other minor advantages that may accrue from their use, yet I certainly do not think it advisable to make a practice of making them as a matter of course, simply because it is possible to make them under certain exceptional circumstances.

# CHAPTER XX.

## BLOWN AND COPPER-BIT JOINTS.

THE foregoing remarks bring to mind some other kinds of joints that are very often used as substitutes for wiped joints, and although they may be advantageous in certain special circumstances, yet there cannot be a doubt that their adoption to any great extent has a tendency to encourage a system of unskilled work that is altogether unworthy of the support of those having a desire to uphold and retain the acknowledged skilfulness of the craft. I allude, of course, to copper-bit joints. Most of the arguments used in favour of them are very much like a carpenter trying to prove that a ledge door is quite as good as one constructed with stiles, rails, and panels. He may argue that if the ledge door is only ploughed and tongued, it will answer the same purpose as the panel door, as far as use is concerned, in every respect. If such arguments were carried to their logical conclusion, and acted upon, the trade of a carpenter would suffer considerably. Not only because the work would be done much cheaper, but the worst effect would be that lower standards of efficiency would be required to carry out the work, and unskilled styles of labour would be encouraged.

Now, although this line of reasoning is generally accepted by those engaged in the other building trades, yet, with regard to plumbing, it is as a rule ignored, and very often, unfortunately, by those engaged in the plumbing trade itself.

It is very often the case that, if a certain style of work

just answers the purpose, in plumbing work the scamping appearance is not taken into consideration. But if anything of the kind occurs in connection with any of the other branches of the building trades, it is condemned at once, and the men are discharged for doing a class of work that is below the recognised standard of efficiency.

The questions have often occurred to me: Why does such a state of things exist? Why do not men in authority, such as architects and clerks of works, insist upon a certain standard of workmanship in plumbers' work, as much as they do in other branches of the building trades? I must admit that the superior styles of work are being appreciated more than they were a few years ago; but there is still much to be done, with the object of raising the status of the craft, by higher standards of workmanship, and by increasing the knowledge of its craftsmen. For after all the men engaged in the trade are very much to blame for the loose way in which much of the work has been carried out. The reasons, or at least some of them, in my opinion, are not far to seek, although they seem to have been quite lost sight of by a large number of men in the trade. Copper-bit work, for instance, has done no end of mischief in this respect. When thoroughly competent men have considered that copper-bit work has been quite good enough for certain purposes, although at the same time they would condemn the introduction of such work into general use, they have overlooked the fact that as copper-bit work requires much less skilful manipulation than the class of work that needs wiped soldering, it therefore gives an opportunity to men outside the trade to take a copper-bit and pass themselves

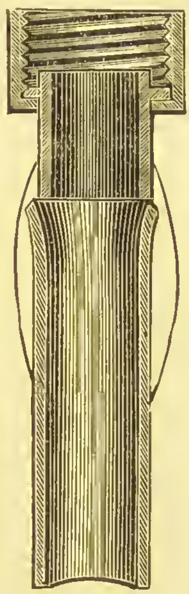

Fig. 108.

off as plumbers; and they are often accepted as such, because they fix pipes and join them together and make them answer the purpose, at least for a time, until the work is altogether out of their hands, and then when the serious defects are afterwards discovered they are at once put down to the credit of plumbers, notwithstanding the fact that the man or men who did the work never were entitled to the name of plumber.

Now, although this class of men generally start with copper-bit soldering, they after a time make an attempt to make a joint by wiping it. The result, of course, is a miserable failure; nothing but a mere botch is accomplished, the shortcomings of which are generally made up with red lead and rag plasters, and other things too numerous to mention. I ought, perhaps, to apologise to my North-country readers for attributing so much bad work to the encouragement of copper-bit soldering, because I know this kind of soldering is adopted in the North to a very great extent, and is recognised as the proper method of making joints and of soldering generally, and no one can deny the fact that the North of England plumbers do some very skilful work with the copper-bit, and, as a rule, far better than London plumbers. But as regards the two kinds of soldering, it is not a matter of ability in the men so much as it is the difference in the two classes of work; one man may, of course, excel the other in the particular class of work he has been brought up to, or *vice versâ*. Nevertheless, writing as I do in the capacity of a London plumber, having been born in the trade, my very firm opinion is, that wiped joints and other wiped soldering are by far the best and most

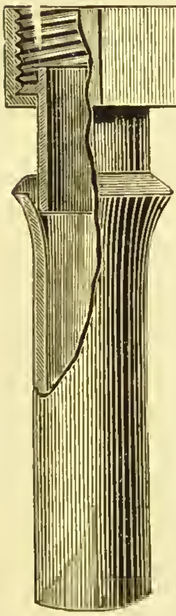

Fig. 109.

substantial style of soldering, and whatever may be the result of copper-bit work elsewhere, my own personal experience has convinced me, without the shadow of a doubt, that it has had, and has still, a very demoralising influence on the trade in and about London. Wherever scamping work is done, the greater part of the soldering is almost invariably done with the copper-bit. This, at least, is the case round about London; not, of course, without exception, but as a rule it is found that incompetent men do not attempt to use the wiping solder any more than they can possibly help. One reason is undoubtedly that of expense, but the principal one is the extreme inconvenience and awkwardness, to which must be added the frequent excuse about the bad quality of the wiping solder. The above remarks will show that, although I shall now proceed to give a few examples of copper-bit joints, they are not recommended for application to general work. But as it is said that every rule has an exception, it may be advisable, perhaps, on exceptional occasions, and under particular circumstances, to break the rule here laid down; not because the copper-bit joint will simply answer the purpose as a mere joint, but because under certain conditions the copper-bit joint may be more suitable and more reliable than a wiped joint.

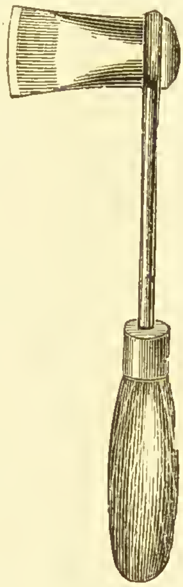

Fig. 110.

It sometimes happens that the lining of a union is so short that if the wiped joint is not made an extraordinary short length, just where most strength is required is very often the weakest place. Fig. 108 is a sketch of a joint of this kind. In cases like this it would be better to make the joints with a copper-bit, or better still the blow-pipe. Fig. 109 shows an ordinary copper-bit joint as it should be made.

It is important that the pipe should be well opened with the turnpin, and carefully shaved inside as far as the brass lining enters. After firmly fixing the brasswork by means of a round stick driven through the lining into the pipe, it should be well sweated and floated with a good hot copper-bit, having a clean well-tinned face. Many use a hatchet bit, as shown at Fig. 110, for this purpose; but, in my opinion, a straight one is the best, or else a bit made to the shape shown at Fig. 111. This is something of a hatchet shape, but the face is not so long, and instead of scraping the solder off the joint as a hatchet bit often does, it is short enough to dip into the socket without displacing the molten solder to any large extent.

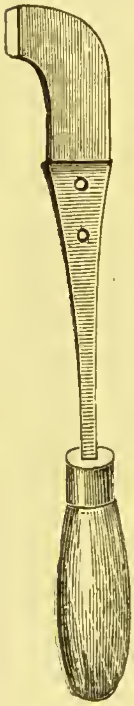

FIG. 111.

As the bit should be used as hot as possible without injuring the face, the soldering should be commenced by holding the face of the bit close to the brasswork; in fact, it is not necessary to touch the lead at all to make a good joint, providing the brasswork is well fitted into the pipe, so that the solder can be properly sweated into the socket without the fear of the solder running down inside the pipe. Fig. 112 is a sketch of two badly formed copper-bit joints that are often made as a substitute for wiped joints by makeshift plumbers.

Persons who do not know the most important principle that should be observed in plumbing joints, make the same mistake with regard to copper-bit joints as they do with wiped joints; they seem to think all that is necessary is to place a piece of solder round the joint, no matter in what form, so long as the two edges are covered and appear secure from the surface. But as I have already stated, the soundness of a wiped joint depends for the most part on the

solder that is sweated between the inside edge of the pipe and the brasswork; so also a copper-bit joint must be prepared in such a manner as to allow the solder to flow in the space between the pipe and the brasswork, as shown at Fig. 109. If a joint of this kind is made with care, it can be made as reliable as a wiped joint; but the fact is, in the hands of men who are not plumbers, it does not receive the care that it would from a competent joint-maker, for although the joint seems very easy to make compared with a wiped joint, yet it does not follow that, because it is simple and easy, men who have had no experience in the trade will carry out the simple rules properly. As a matter of fact, it will be seen that whenever a mechanic interferes with trades that he has no business with, he almost invariably neglects the simple rules on which often depends the success of the work, because they are either considered only of minor importance, or else through want of experience they are hardly ever noticed, and therefore seldom learned.

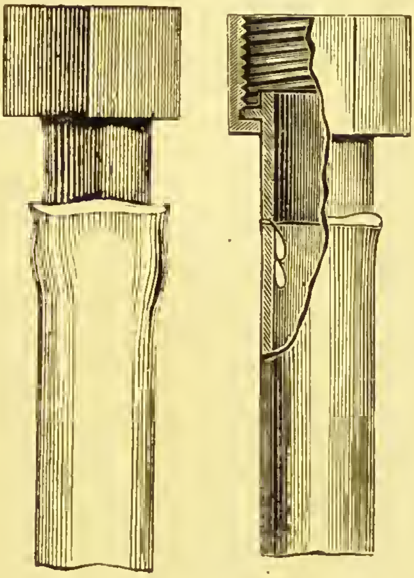

Fig. 112.

The methods adopted for forming joints, and the means used for applying heat for the purpose of soldering, even for joints on small service and other pipes, are so numerous and varied that one is almost afraid of wearying his readers by continually enlarging on one particular part of the subject of joint-making.

My excuse is, if any were needed, that if hints on joint-making are at all necessary, it is very often the case that

what are considered the minor matters and of least importance are just the very things that are the most neglected, and which tend to the production of a bad and demoralising influence on the more important parts of the work. When plumbing work is not only badly executed, but is executed by what are generally supposed to be cheap and simple means, and by men who cannot do it in any other way, the word "bad" does not adequately describe it; it is scandalous and often criminal. Therefore, simple as some of the means used may be, and considering the danger that often results from their very simplicity, it is incumbent on one who attempts to write on these matters to try and show how to make the best of even a bad system. Because, do what you will, there will always be some who will push in the inferior styles of workmanship wherever there is an opportunity. Of course there are many persons who are entirely mistaken when they suppose that what I have described as inferior styles of workmanship is more economical than the more skilful methods that are generally employed.

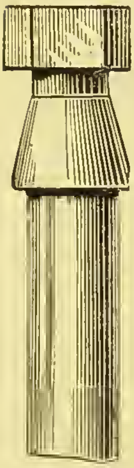

Fig. 113.

It may be observed in numerous instances that the style of work that requires less skill, especially if it is executed by an inferior class of workman, is more often than not very much more expensive than the better classes of work.

There are, for instance, several kinds of copper-bit soldering that require a large amount of labour for cleaning off the joint before it is considered fit to be left as finished. Fig. 113 shows a joint of this kind; it is called a band joint. The pipe and brasswork are prepared in the same manner as an ordinary wiped joint; the solder is placed round the joint, in a horizontal position, with a copper-bit roughly. This might very appropriately be termed a tinker's joint, for

it does not matter how roughly the solder is placed round it, as it can be cleaned off with a rasp and file as smooth as the surface of the pipe, if it is required. A joint of this is not often made in a fixed position; it is generally used in the case of a short union on a trap, or in some other cases where it can be made on the bench or some similarly convenient place. The band joint cannot very well be recommended for general use, as it certainly is not good workmanship, at any rate from a plumber's point of view. The only thing that might be said in favour of it is, that where joints have to be made on very short unions or linings that are not long enough for proper wiped joints, band joints have a neater appearance than the ordinary copper-bit or blown joints, therefore they are often made with the object of putting a better finish on the work.

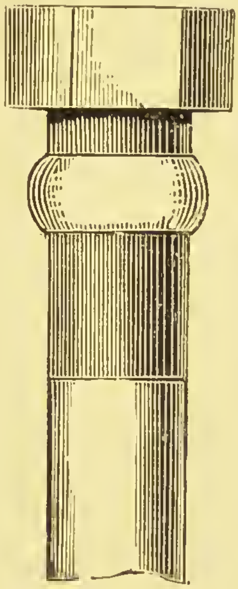
Fig. 114.

Another kind of copper-bit joint is known by the name of a bead joint. The appearance is very similar to a band joint, but it is generally made rather narrower. Fig. 114 is a sketch of this kind of joint. The North of England plumbers make this style of joint very neatly. After preparing the joint in the usual way, but with the shaving rather narrow, the fine solder is placed round with a straight copper-bit, having a somewhat narrow point, as shown at Fig. 115. When the joint is well tinned, and a proper amount of solder is placed round it, the pipe is laid horizontally on the edge of the bench, or on two blocks, in the same manner as a rolled joint would be. Then with the bit well faced and not too hot, the solder is floated round while the pipe is rolled over with the left hand. Although it seems a very simple process, it will be found to be very difficult to those who have not

practised it. One of the principal means of success is the proper heat of the bit. If the bit is too hot the solder will very quickly flow off on one side or the other, and if it is not hot enough the result is a very rough job.

The use of the copper-bit for this purpose requires almost as much practice as the wiping of joints. While most plumbers can use the copper-bit sufficiently for making a joint sound, there are comparatively few who can make a bead joint as smooth and clean as if it were on a flat horizontal surface. Yet there are men who are skilful with the copper-bit that make these joints as smooth as the seam would be on a straight piece of soil pipe. I should not recommend this kind of joint except in special cases, because, although the joint is made very neat and reliable in some instances, it, like most other copper-bit soldering, offers opportunities for botching work by men who can only use the copper-bit, and that very unskilfully.


FIG. 115.

Two other kinds of cooper-bit joints are shown at Figs. 116 and 117 ; these are what are sometimes called facet joints. They are prepared in the same manner as the band and bead joints, but instead of the solder being cleaned off or floated, it is simply arranged in facets the whole length of the joint in one case, and half the length in the other. A very strong joint can be made in this manner, and if the facets are regularly arranged the joints have a very pretty appearance. This kind of soldering also requires a large amount of practice before a respectable joint can be made in a reasonable time. I say a reasonable time, because the copper-bit is very often used and recommended on the ground that time is saved by making joints with the bit instead of wiping them. But according to my observation this has often been a great mistake. In the case of band

and facet joints, while many men are tinkering about with the bit, they could prepare and wipe the joints in half the time, and at the same time make a much better job of them, even if the fact is not taken into consideration that the wiped joint is, from a practical point of view at least, the most workmanlike and satisfactory.

Now, although plumbers as a general rule do all they can to show their joints to the best advantage, they try to keep them clean, and take the trouble to touch up the soiling, and are very much disappointed when a painter

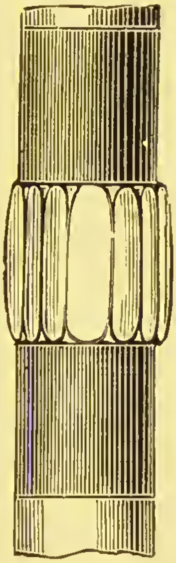

FIG. 116.

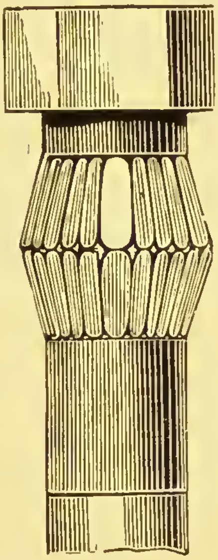

FIG. 117.

hides the silvery bulbs with his decorative material. Yet as there are secrets in all trades, the plumbers also, or at least some plumbers, have their secret joints, which instead of trying to make conspicuous, they use means to conceal as much as possible. Not that secret joints are made to any great extent; as a matter of fact they are very rarely required in ordinary practice, but as they may be made useful in some cases, it will not, I think, be out of place to describe them. The worst thing about secret joints is that, while they, like many other matters in connection with

practical plumbing, are very good and perfectly reasonable when adopted with discretion and used in their proper places, there are so many persons, who, when they learn of anything out of the ordinary way, especially if it can be done by the tinkering process, will use it under nearly all circumstances, no matter whether they are suitable or not, with the result that the whole thing is condemned and looked upon as a system of unmitigated scamping. Fig. 118 is a sketch of one kind of secret joint. It is very easily prepared; the spigot end of the pipe is rasped in much the same manner as it would be for an ordinary joint, but care should be taken to rasp the end as square and true as possible; the bevelled edge also should be regular and even. The bevelled edge should then be carefully tinned with a copper-bit or blow-pipe. As a blow-pipe is much the best means to use for finishing the joint it is best to use it for tinning also.

The socket end, instead of being opened with a turnpin, as it would be for most other joints, is only bevelled inside with a rasp or half-round file, until it is deep enough to receive the bevelled end of the spigot. The inside bevel should also be tinned to correspond with the tinning on the spigot end. The tinned faces being brought together, a blow-pipe should be used to sweat the two ends of the pipe as close together as possible. The spigot should be pressed into the socket while the pipe is hot, so as to squeeze out the surplus solder. When the joint is cool it can be cleaned off with a file, and if it is neatly made it will be almost invisible. Joints of this kind are very useful in cases where a pipe, from a waste-preventing cistern for instance, has to be lengthened. Where they are fixed on the face of a wall a wiped joint would sometimes look superfluous; or they might be used to lengthen short air pipes on external walls, and in many other cases where there is no pressure of water to withstand.

Fig. 119 is another kind of secret joint I have seen made in cases similar to those already mentioned. In this case only the two square ends are tinned and sweated together, either with a blow-pipe in an upright position, or laid horizontally on the bench and sweated round with a copper-bit. Sometimes lighted shavings are used to sweat the joints in an upright position, but this, of course, is only a makeshift, and is only done when a blow-pipe is not obtainable.

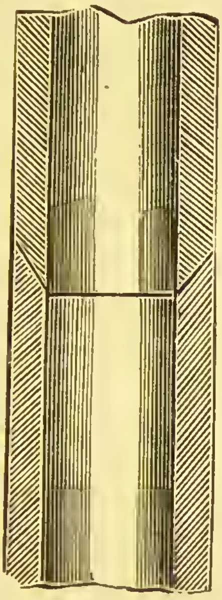

FIG. 118.

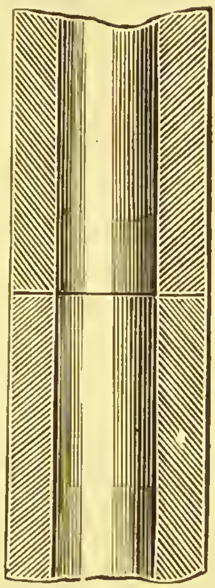

FIG. 119.

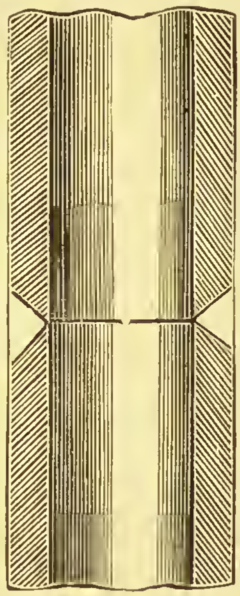

FIG. 120.

Fig. 120 is yet another style of secret joint, and is, as a rule, the most reliable, although it is not so easily hidden, at least so far as the difference in the colour of the solder and the lead is concerned. The soldering has, of course, to be done with the pipe in a horizontal position; this is generally done roughly with a copper-bit, and cleaned off afterwards with a rasp and file.

The most effectual and complete secret joint is made by what is termed the autogenous soldering process, or in other words, lead burning, because as no solder, properly so called,

is used, but only strips of the same metal as that which has to be joined, it is of course possible to clean it off in such a manner as to have no trace of any joint at all. Not that lead burning can be recommended for general use in the place of soldering, because there are many parts of plumbing where it would be inferior to soldering. Before leaving this part of our subject and proceeding with the consideration of branch joints, I feel compelled to state most emphatically, that although I have described at some length the different methods of making joints with the copper-bit, it is only with the object of interesting those of my readers who have few opportunities of knowing the several means used for making joints under various circumstances, and to warn others of the evil effects that generally result from the injudicious use of the copper-bit by many plumbers. We have heard so much of late years about the scamping work executed by so-called plumbers, and as I have already mentioned the undoubted fact that a very large proportion of the condemned work has been done by men who cannot use anything better than the copper-bit for making joints and for other kinds of soldering, and that very imperfectly, it makes one very reluctant to write anything at all about copper-bit work, for fear it should lead to any misunderstanding, either by the encouragement it might give to its further use by *bonâ fide* plumbers, or by the insight it may afford to unscrupulous and botching workmen who have been the means of bringing discredit on the trade, and, what is more serious, endangering the lives of the community by unsanitary work.

## CHAPTER XXI.

### BRANCH JOINTS.

THERE are many other styles of upright and underhand joints yet to be considered, especially with regard to joints on soil and other large pipes. But before taking up that part of the subject, which, by-the-bye, will suggest many matters of interest, particularly with regard to sanitary plumbing, it will be best to take branch and other similar joints on small main and service pipes into our consideration first, so as to complete one part of the subject before proceeding with another. Branch joints, like the other kinds of joints already described, depend to a very large extent as much on the way they are prepared as they do on the way they are wiped—at any rate as far as their soundness and reliability are concerned—especially where they are subjected to a great pressure of water. It may generally be observed that the preparation of branch joints is very carelessly performed; the principles that are considered necessary in the preparation of straight joints are, as a rule, ignored when a pipe or a brass fitting is to be soldered into the side of another pipe. It is difficult to say why this is so, except it is because branch joints are not supposed to be so liable to sweat as straight joints. But this is not always the case; branch joints will sometimes sweat very badly, especially if the solder happens to be rather coarse and the joints are wiped without an iron being used; and as it is a very difficult matter, in most instances, to wipe a branch joint over again after it is fixed—more difficult by far than an

underhand or upright joint—it is most important to take care to prepare the joints in the best manner possible, and thus avoid much trouble and expense after the work is fixed and tested. When one pipe has to be branched into another, the branch pipe should be prepared first. The end should be properly squared and tapered with a rasp, in the same manner as already described for ordinary straight joints. When soiled it should be shaved about half or two-thirds the length of an end prepared for an upright joint. Now the most serious faults in branch joints occur in the preparation of the hole into which the branch pipe is fitted. One very scamping style is to cut a straight opening, as shown at Fig. 121; this is opened roughly with a bolt, and the branch inserted without any care being taken to properly fit it. After some time being spent in trying to close up the edges to the clumsily-fitted pipe with the back of a knife or the edge of a chisel, the solder is splashed on, with the result that much of it has run through into the pipe, and the joint is totally unfit to stand any considerable pressure. Another plan that cannot be recommended is to nearly rasp the pipe through with the round side of the rasp, so thin as to enable the point of the bolt to be pushed through it, and the hole opened with only two or three blows with a hammer. Some, of course, will say this way of doing it answers the purpose very well, and is, as a rule, satisfactory. But that is not the question; there is a right way and a wrong way of doing everything, and very often the right way is in the long run the quickest and undoubtedly

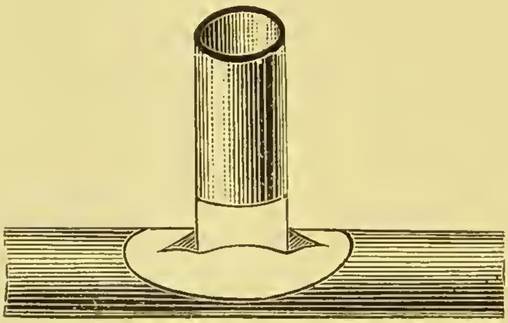

Fig. 121.

the best, although it may appear to require a little more care and labour at first. The idea should be, in the preparation of all joints of this kind, to form a socket, the spigot being fitted into it in such a manner as to need no tapping up to prevent the solder running through, because, as explained in regard to the straight joints, the very act of closing up the socket deprives the joint of one of its most important, if not its vital, principles, especially if the solder should happen to be rather coarse or otherwise not in a proper condition. Figs. 122 and 123 illustrate this. Therefore when making a hole in the pipe, as little as possible should be taken out. Either a gimlet should be used, or a small hole made with the point of a knife or a shave-hook, but a gimlet is decidedly the best tool to use, because it makes a regular hole that is not so liable to tear when it is being opened with the bolt.

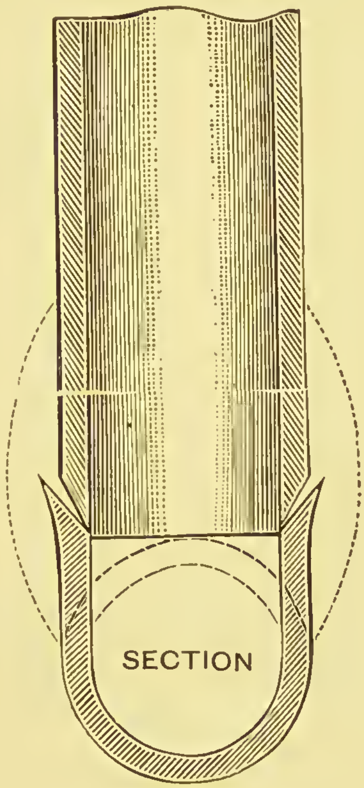


Fig. 122.

After being opened out to the required size with a hammer and bolt, and care being taken to work the edge upwards, it should be made the exact shape for a socket by means of a turnpin being driven in and the sides dressed to it.

The rough edge, if there is any, should then be cleaned off with the rasp, and after soiling and shaving the joint as shown at Fig. 123, the inside of the hole should be shaved as far down as the other pipe sockets into it. If the joint is made on the bench it should be fixed as shown at Fig. 124.

It is not a good plan to fix a branch joint with two or three short spikes driven into the bench, as these are generally in the way and make it very inconvenient to get at the joint when it is being wiped. Some plumbers fix joints in such a manner as to make it quite a dexterous performance to wipe the joint at all; while they are dodging in and out of their awkward fixings, the heat is gone before the joint can be finished. In fact, I have known cases where the fixing has had to be taken down and another

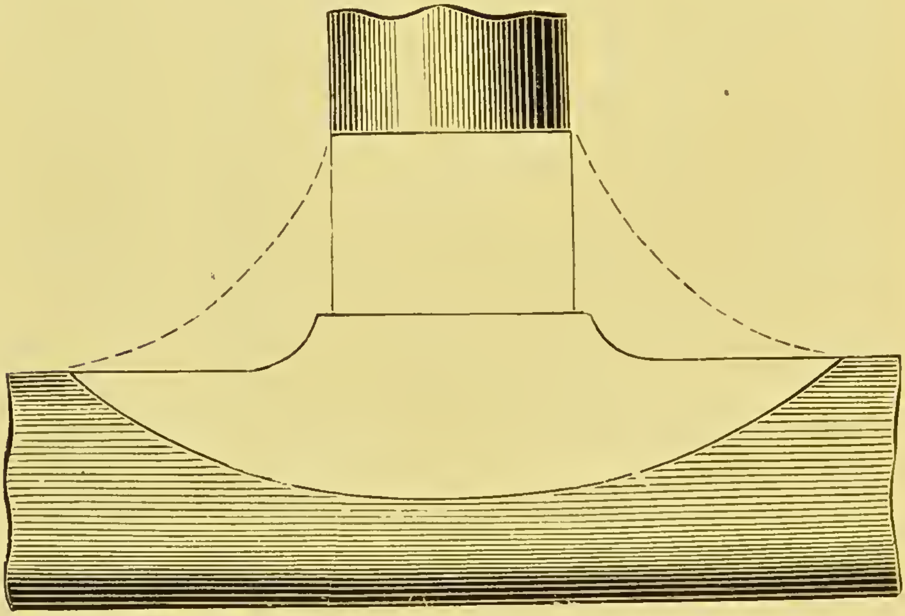

FIG. 123.

substituted before the plumber could make the joint to his satisfaction. It appears to me very often, that there is almost as much skill in the fixing as there is in making the joint.

The two most important things to be remembered when fixing branch joints are to get the pipe firm, so that it will not vibrate, and to give as much room as possible for the hands to get round it. The former can be done by keeping the blocks as close to the joint as possible and fastening the

pipe to them, and the latter by tacking the ends of two pieces of lath to the bench and tying the other ends to the branch pipe so as to form two braces as sketched at Fig. 124. Now in regard to wiping the joint, one important thing is the wiping cloth. This should not be a thin one, but should consist of about six thicknesses of moleskin cloth, and, supposing the joint to be $\frac{3}{4}$ inch, the size of the cloth should be about $2\frac{1}{4}$ inches by $2\frac{1}{4}$ inches. As a rule, cloths used for

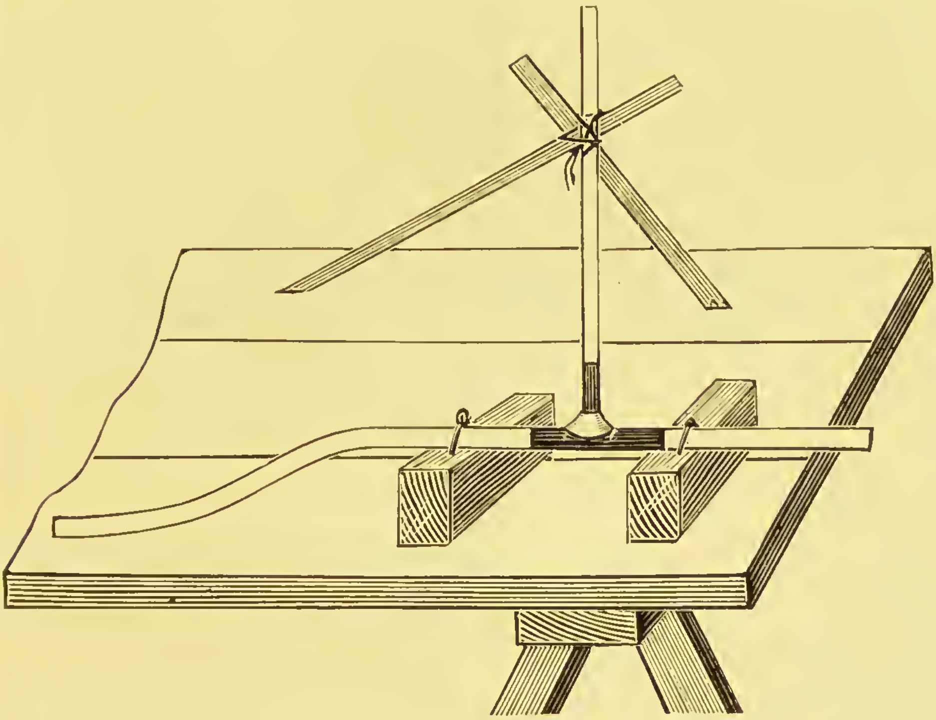

FIG. 124.

this purpose are very much smaller than the above size, the result of which is, to a great extent, the many bad-shaped joints that are to be seen in different parts of the country.

Fig. 125 is a sketch of a bad-shaped joint that is often made with a thin cloth, but Fig. 126 shows a joint that is much more easily made with a comparatively thick cloth. When all is ready and the solder is at a fair heat, it should be splashed on carefully, at the same time warming the pipe

for a few inches each side of the joint with the solder. When the whole of the solder on the joint is at such a heat as to make it difficult to keep it on the pipe without continually drawing it up with the splasher, take a small clean iron at a dull red heat, and start wiping at one end of the joint ; carefully form the sides of the joint, and wipe the

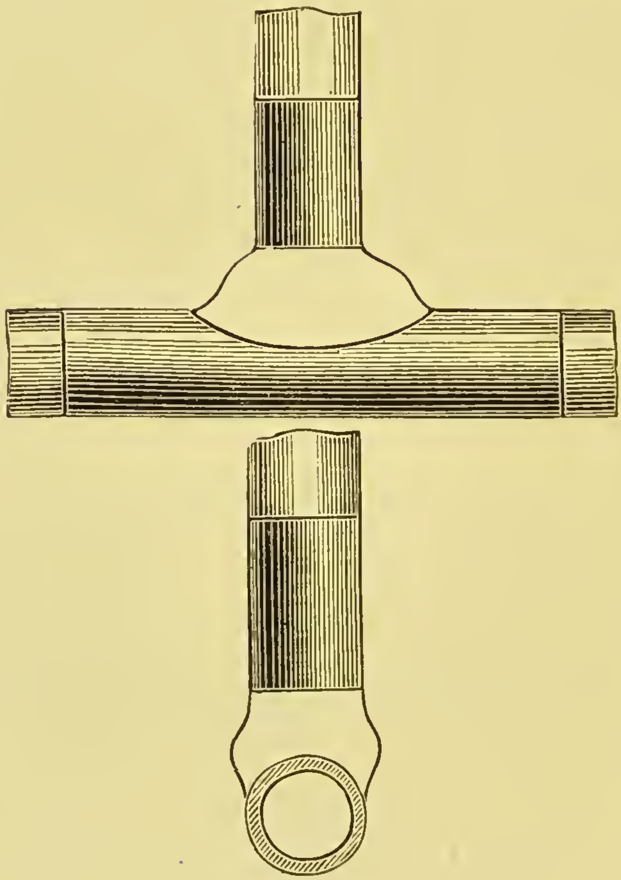

FIG. 125.

solder as hot as possible by the continual application of the iron before each part is wiped. Finish off the joint at the same end as the start was made, by drawing the wipe-off to the outside edge of the end of the joint. It is a mistake to try to hide the wipe-off by drawing it to and fro until the joint is cold ; this spoils the look of it by making it look dull

and dirty. This brings us again to the subject of the plumbing iron. If there is one kind of joint more than another which, to my mind, requires the aid of an iron, it is certainly the branch joint; but this also is being made, to a very large extent, the subject of much abuse through the anti-iron craze. Men who have been taught to use the iron

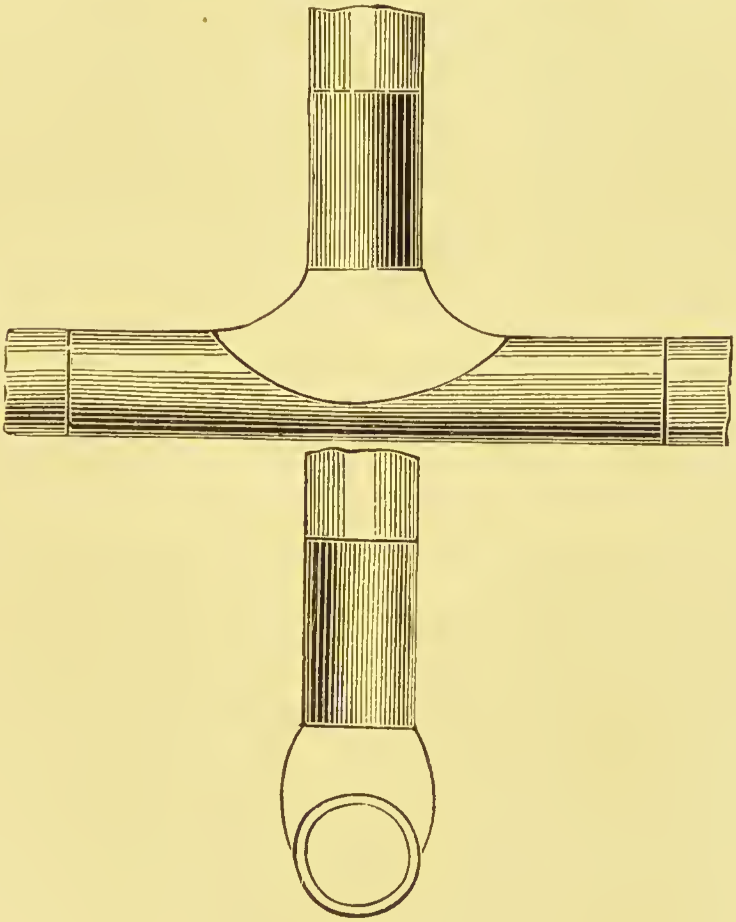

FIG. 126.

for every kind of branch joint, by the aid of which they are able to make good, clean and bright joints with the *first heat*, without the slightest difficulty, have suddenly within the last few years thought it clever to do without the iron, the result of which has been, in the vast majority of cases, discreditable to them from every point of view. Joints made

by the anti-iron system are, as a rule, bad both in shape and colour, besides being porous, as already explained in a previous chapter, and the time absolutely wasted by repeated wipings is beyond all reason. A case in point came under my notice a short time ago. A plumber who is acknowledged to be a first-class tradesman in all branches of the craft, had some $\frac{3}{4}$ branch joints to make on some tin-encased pipe. Now every one who has had anything to do with tin-encased pipe knows that if the joints are wiped at all, the tin lining is sure to run more or less according to the amount of heat used to make the joints, consequently as small an amount of solder as possible should be splashed on, and no great heat raised, and an iron should be used so as to wipe the joint off as soon as possible. But the plumber above mentioned, instead of doing it as he should in the quickest manner possible, had been infected with the anti-iron delusion, with the result that, instead of making the joint quickly with the first heat, he repeated the process of splashing on and making futile attempts to make a passable joint no less than six times, each time making a worse joint than the one preceding it. After being remonstrated with by the foreman plumber for his ridiculous proceedings, he had to use an iron after all. Now such a course of action would deserve to be condemned under ordinary circumstances, but when the joints were being made on tin-encased pipe, which in any case required much care and consideration, it seems altogether unreasonable, to say the least, to discard the iron when its aid was most necessary.

One would not be so surprised if it could be shown that the use of irons was in any degree detrimental to the appearance or efficiency of joints. But as far as my experience goes the most ardent advocates of joints without irons have no argument, and hardly any reason, to give why they try to do without them.

As branch joints are more irregular in shape than upright joints, more time is required to form them properly and get the edges clean. If an iron is used time can be taken to wipe the joint leisurely and carefully, but without an iron it has to be hurried, and wiped off before there is time to see if the edges are clean or the joint a proper shape. And when it is done it is generally nothing but a chalky-looking porous quantity of solder, that has not been used to the best advantage.

Then follows the use of touch or grease. We have already explained the reason why it is used before the joints are made, but why it is rubbed over a joint after it is wiped is not very clear to most people, and sometimes not to plumbers. It is a debatable question as to whether it is really any benefit to the joint or not. The main idea with most plumbers is to clean it; this is done by rubbing the touch on the joint while it is hot, and wiping the surplus off with a clean rag. But it is not absolutely necessary, because a stream of clean water from a ladle or other vessel will have the same or a similar effect. There are many who consider, with some reason, that the touch is absorbed by the porous solder, the pores of which are partially filled up, and when the joint is cold, prevents the water sweating through. But I know one authority who says that this is erroneous, although to my mind it is perfectly reasonable to suppose that, if a joint is made in such a manner as to leave the solder in a spongy state, as it really is if it is porous enough to sweat, the touch will enter the interstices by capillary attraction, as it would any other body under the same conditions. This being the case, there cannot be any doubt that the touch absorbed by the solder does to a very large extent prevent numerous joints from sweating, that otherwise would have to be wiped over again. Therefore we may consider that touch to plumbers is as valuable as putty is said to be to carpenters, for in each case they cover a multitude of sins.

# CHAPTER XXII.

## BRANCH JOINTS (*Continued*).

IN the latter part of the preceding chapter we were discussing whether it was necessary to use touch for the purpose of saturating a joint just after it is wiped, with the object of preventing percolation, or what is commonly called sweating. But before passing on with our subject, it will be well to point out the fact that, although under certain conditions the practice may be advisable, yet there are circumstances under which it would be absolutely useless, that is, so far as regards the idea of its preventing sweating. For instance, where joints have to be made on connections to hot-water services, the touch that may have been absorbed by the joint will melt with about 100° of heat; therefore, as soon as the hot water passes through the pipe on which the joint is made, if the joint is porous enough to sweat, the touch will be forced out of the interstices as easily as the water finds its way through, even under moderate pressure. The expansion produced by heat, undoubtedly renders a joint on a hot-water service more likely to sweat than it would on a cold-water pipe. Consequently, more than ordinary care is necessary in the preparation and the wiping of joints on hot-water services, and the idea about the efficacy of touch should be left out of consideration altogether, and proper means should rather be used to make the joints non-porous.

There is another serious fault in connection with porous joints on hot-water services, especially with regard to joints

to brasswork. It is generally supposed that sweating joints will, after a short time, have the pores filled up with solid matters from the water, and so take, or heal, up. This is the case, as a rule, with cold water if the joint is not too bad, but in the case of hot water the sweating often gets worse, and in several instances I have seen joints broken in two by the action of the water decomposing the solder by its oxidising and carbonising influences.

The latter action takes place in most cases when the joint is wiped very light, or when the thickest part of the joint, by reason of its bad shape, is not round the junction of the two pipes, or where the brasswork joins the lead. But there are instances where the joints are a good shape, and have a fair proportion of solder on them, yet owing to their porous nature, and being subject to the action of hot water, they have been apparently eaten through in a few months.

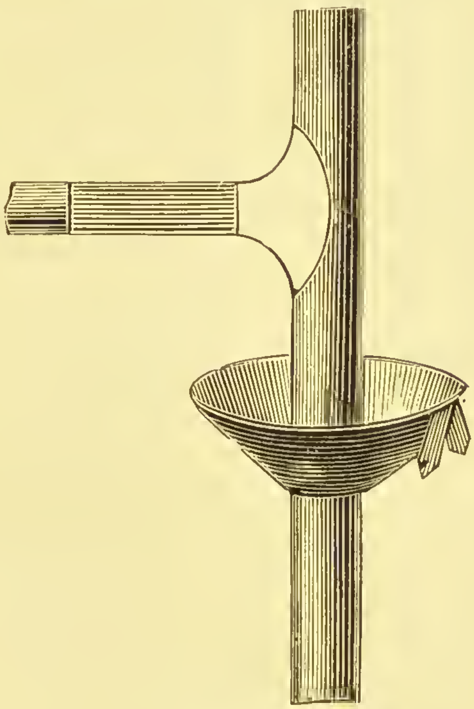

Fig. 127.

Heat, as we have already explained, facilitates oxidation, more especially moist heat. The consequence is, if the joint is in such a condition as to allow the water to percolate through the solder, the oxygen in the water will very soon decompose the particles and turn them to an oxide ; this, in turn, is dissolved by the carbonic acid in the water, and so the process goes on until the joint is eaten through and ultimately breaks in two. Now the principal cause of this

action is generally the careless way in which the ends are prepared. If the joint is made sound where the two ends meet, as already explained, the percolation cannot take place, even if the solder should happen to be rather coarse, or otherwise in a bad condition. But if the joint is badly fitted and the solder is badly used, the best solder made will not form a good joint either as regards sweating or in appearance.

The importance that is attached to the proper methods of preparing the ends of pipes and opening of holes for branch joints, is being recognised by the examiners both in the City Guilds examinations, and in the practical tests applied by the examining committee for the registration of plumbers. Instead of simply wiping round solid pieces of pipe without any cut in them, as is very often done for practice, the candidates are required to prepare their pipe as if it were for ordinary use. This is as it should be, for there are many who learn to wipe a joint before they have mastered the art of preparing the ends; in fact, there are some who want to make joints before they have learned how to get the solder hot.

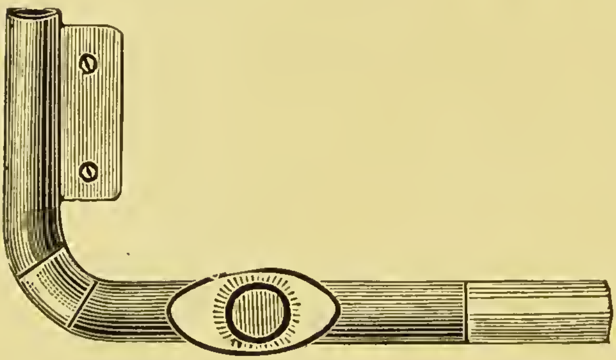

FIG. 128.

My rule in class teaching is always to insist upon all students preparing the ends of pipe in a proper manner before attempting to practise joint-wiping even if they use uncut pipe afterwards.

But to return to our branch joints. These, like all other kinds of joints, cannot always be made on the bench; some

have to be made upright and others underhand, and a most unusual style is to make them upside down, but still they can be done, and sometimes have to be made in the latter position. Next to the ordinary style, as Fig. 124, they most frequently have to be made upright. This happens when branches have to be made to main services after they are fixed. As a rule, this is avoided as much as possible by wiping in a short branch on the bench before the main pipe is fixed. But as this is not always convenient, the branches have therefore to be wiped in their place. These joints are not so difficult as they are generally supposed to be. When

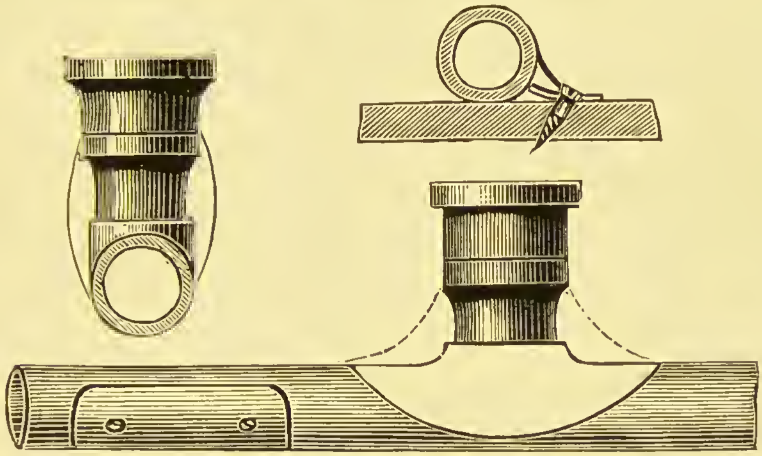

Fig. 129.

fixing them a collar should be used, as when making an ordinary upright joint, as shown at Fig. 127.

After splashing on the solder, and when a good heat is obtained, take a small iron and a branch cloth, and start to rough it into shape by making free use of the iron, removing some of the surplus solder with the cloth. Then commence wiping at the bottom of the left hand side, wiping upwards to the top, taking care to get the edges clean. Now wipe over the top and down the left hand side, well warming the solder up before each, or say each second, stroke of the cloth, and wipe off on the bottom edge of the shaving on the main pipe. In many cases if the joint is wiped in the way above

described, it can be done without the cloth changing hands, but where it is in an awkward position it is sometimes best to start from the top on one side, and then change hands to wipe the other side from the top, finishing off at the bottom in either case. After all, it is very difficult to lay down any hard and fast rules as to the way and manner in which joints should be wiped. It depends so much upon circumstances, that what would apply in one case would not be at all suitable in another. For instance, I have had to make upright branch joints in such a position as to be compelled to wipe them in a manner just the reverse to that above described—namely, to start wiping at the bottom, drawing up each side, and wiping off at the top. But the

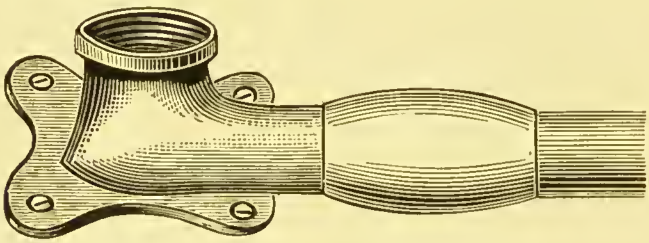

FIG. 130.

latter style does not make such a clean joint, because if the solder is fairly good the tin will be sure to run to the bottom, after the wiping is commenced, and if an attempt is made to touch the bottom after it is once left, with the cloth, the result is a very rough job indeed. This style of joint more than any other should be wiped very quickly, especially if it must be started at the bottom, for the longer one is over it the rougher will be the joint.

Branch joints are also made underhand, but this is not very often necessary, although I know at least one plumber who preferred to make branch joints underhand. I do not know why he made them in this manner, but presume it was customary where he learned his trade, and that was somewhere in the North of England. To my mind, an under-

hand branch joint is the most awkward joint that it is possible to make, especially when they have to be made on small pipes. On large pieces of soil-pipe work they are often very convenient and sometimes really necessary, but, as a rule, they can be generally avoided on small pipes. But if it should be necessary to make one underhand on small pipes, the best way is to use an underhand cloth when pouring the solder on to get the heat up, and then to take an ordinary branch cloth, wiping from the bottom up each side to the top and wiping off either on the edge of the shaving on the branch side or else on the main pipe side, whichever is most convenient.

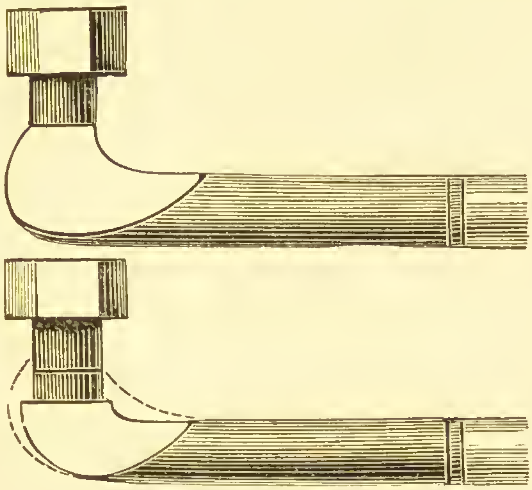
Fig. 131.

It is a mistake to wipe this kind of joint round and round like an ordinary underhand joint, as it generally makes a very rough job of it; the quicker it is wiped off, the cleaner and better the joint will be.

Fig. 128 shows another branch joint on the brass boss of a bib valve; it also shows the end of the pipe turned up and a face tack soldered to it for the purpose of screwing the pipe back to the wall; fixing for the screws is made either by letting in a block, or driving some plugs in the wall behind the tack.

This style of fixing is very firm and substantial, and is well worth the extra time and material as compared with one or two wall or pipe hooks. The advantage of the end being turned up is obvious; it of course forms a bracket which keeps a bib valve from being bent down and the pipe

working loose, as is often the case when they are fixed in the ordinary way. Where there is no room to turn the end up or down (either way answers the same purpose) the tack can be soldered on as shown at Fig. 129. When there is a wooden fixing at the back, such as a flashing board or the stud of a wooden partition, nothing is more suitable than the screwed face tack. That is so far as lead solder is concerned, but if a brass elbow boss is used, as shown at Fig. 130, of course this is the best possible job that can be made of it.

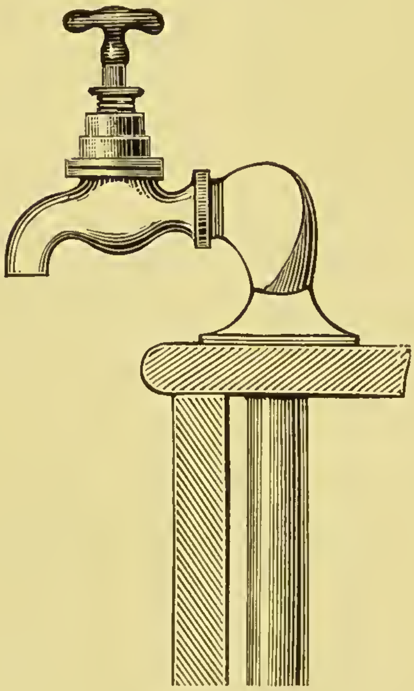

FIG. 132.

This consists of a cast brass elbow, with one end tinned for lead and the other screwed to take the thread of the valve. On the back is a flange with four screw holes in it; altogether it makes a very neat and strong fixing either for ball valves or bib valves. Brass screws should be used to fix them with, as iron screws soon rust and are difficult to get out when it is necessary to move the boss or pipe.

Fig. 131 is the sketch of a joint very much akin to a branch joint. It is generally termed a knuckle joint, and is more suitable than a branch joint in many instances. There are many plumbers who make branch joints in all cases where they cannot find room for straight joints, but in my opinion branch joints are only required where fixings are wanted close to the joints, such as those to bib and ball valves. In cases where joints have to be made to caps and

linings on ball valves and overflows to waste water preventers, or connections to iron or slate cisterns, the knuckle joint seems to me the most suitable for the purpose. In instances of this kind the knuckle joint looks as if it were made for the purpose, but the branch joint does not; it has the appearance of the pipe having been continued on at some time, and then had to be cut off and stopped up. If it were used for fixing purposes, it would, of course, be entirely different. Fig. 132 shows another use for a knuckle joint combined with a flange joint. This makes a neat job where a sink is fixed in a window opening, and there is nothing to fix the valves to except the window board. The knuckle joint should be first made on to the boss, then a collar prepared, as shown, with a soiled margin about half an inch wide. This collar could be wiped on the pipe on the bench if it is fixed through a piece of board with a hole in it, or it could be wiped in its place, although, if the window board is painted, it would be better to wipe it on before it is put in its place, to prevent the solder burning the paint off the board. Before wiping the flange joint, the knuckle should be protected by a piece of pasted paper cut into a long strip and bound round it. It can be held secure in its place by three or four brass screws driven through the edge of the soldering of the flange into the woodwork. This arrangement has the appearance of being weak between the two joints, and some would think likely to break off very soon. But in my experience they have been found to be quite strong if the flange joint is wiped up the knuckle a little way so as to join the two solderings together, and there is no difficulty in this if the paper is pasted on carefully and a good iron is used to well warm it up before it is wiped. If the flange is wiped in its place, this can take the form of a taft joint, by tafting the end of the lower pipe on the collar, and socketing the other piece with the knuckle joint into it.

# CHAPTER XXIII.

## BLOCK JOINTS.

THE subject of joint-wiping is one of such an extensive character, and which admits of such exhaustive treatment, that one is at a loss to know where to leave one branch of the subject, and pass on to another. So much more could be written with regard to joints on small pipes, and the various means used by different classes of plumbers to obtain the same result, that to one having had considerable experience, both from personal practice and from observing the ways of all sorts and conditions of actual and professed plumbers, it would be possible to go on almost any length with matter that would perhaps interest some, but would no doubt try the patience of most readers.

Therefore we will leave the subject of small joints, and take into consideration the various kinds of joints used for soil, wastes, and ventilating pipes; and as we have already mentioned flange joints in connection with small pipes, it will be as well to take them first, as applied to large joints.

The most simple form of flange joint is what is generally called a taft joint. Fig. 133 is a sketch of a joint of this kind on a soil pipe, but it is shown, as they are very often made, faulty in its arrangement and construction. These joints are also called block joints, because wooden, and sometimes stone, blocks have to be used when this kind of joint is required. Not that a block joint is necessarily a taft joint, because, as we shall presently show, a block joint can

be made more secure, at least according to the opinion of some, without tafting the pipe at all.

The principal faults that are to be found in block and taft joints are, as is the case with ordinary round joints, in the preparation of them.

In the first place the hole through the block is too small, and fits the pipe too tight.

Then, instead of rounding the top edge of the hole, as

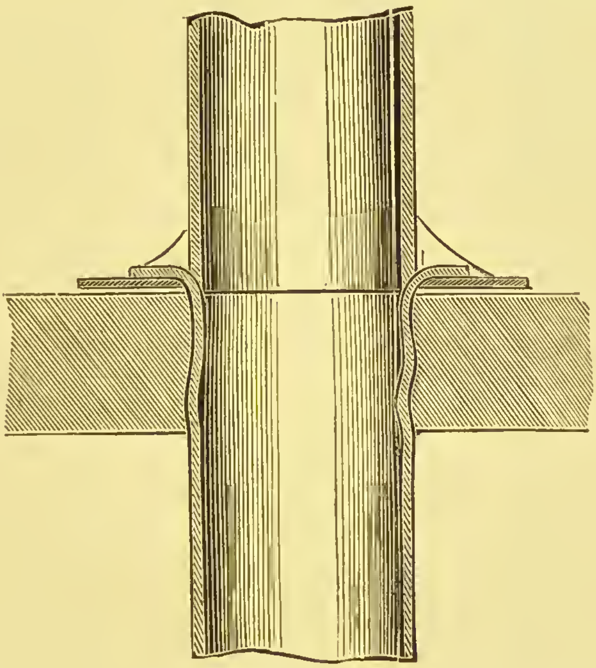

FIG. 133.

shown at Fig. 134, it is left quite sharp, just as the saw left it; the flange is also made to fit close round the pipe, after which the edge of the pipe is tafted sharp over and flattened down with a mallet, or even a hammer. The result is, the taft is formed with a sharp angle at the edge of the hole in the block, which is, notwithstanding the strong soldered joint, a source of weakness, that under certain circumstances will soon break away, and cause much difficulty. I have had to cut several of this kind of joints out that have

broken off round the top edge of the block, almost as clean as if they had been cut. Of course these fractures generally occur where there is considerable expansion and contraction in the pipes, such as waste pipes that have hot water discharged down them. But they also very often take place in soil pipes where they extend to over forty or fifty feet, and therefore expand, under certain conditions, to such a

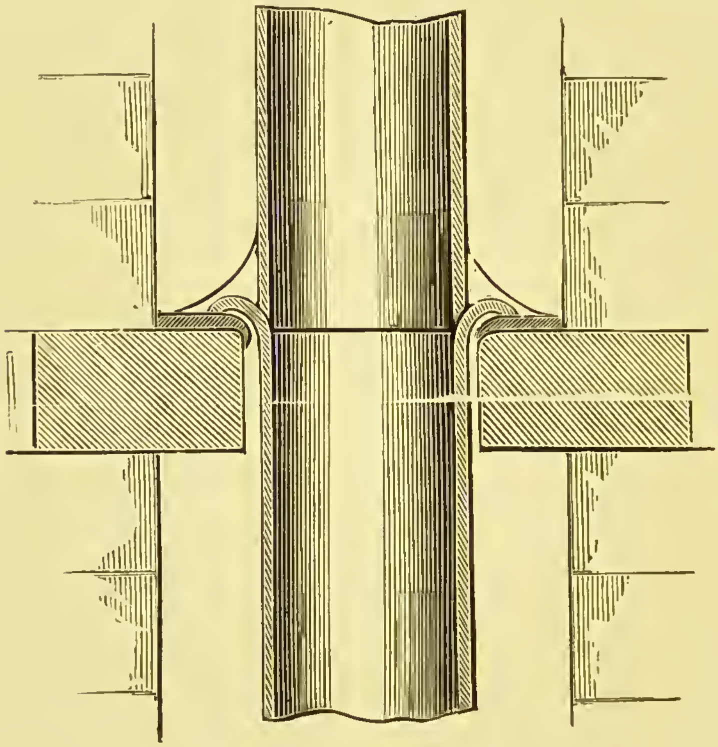

Fig. 134.

degree as to break, where the joints are fixed, rigid and immovable to the expansive force that always takes place, more or less, in leaden pipes, whatever they are used for or wherever they are fixed. Block joints differ from the ordinary upright or round joints in one very important particular, and that is, they serve as a means of fixing the pipe, as well as joining two ends together. And as all leaden pipes that are liable to considerable expansion should

be fixed in such a manner as to give room for a certain amount of movement when the pipe is subject to sudden variations of temperature, it therefore follows that joints which tend to hold the pipe very rigid should be made with a view to give as much play as possible under the circumstances.

It is also advisable not to weaken the pipe either by tafting it to a sharp angle, or by shaving the end of the pipe too deep so as to weaken it at the edge of the soldering.

Therefore when making an ordinary block or flange joint, the block should be not less than two inches thick, and should have a bearing on the sides and back of the chase about two and a half or three inches. The hole in the block should be cut about three-quarters of an inch larger than the pipe, so that there is about three-eighths of an inch space all round. The top edge of the hole should be rounded off as shown at Fig. 134. After the end of the pipe is made to stand about an inch above the block, prepare and tin a flange about an inch and a half wide, soil both sides, and shave it about an inch and a quarter wide, leaving about a quarter of an inch soiled margin. The flange should not fit the pipe tight, but be made to slip on easily. Then take a large turnpin and open the pipe equally all round, and finish turning the edge with a flat face mallet and dresser. Fig. 135 shows the shape of a mallet most suitable for this purpose. Instead of making a flat taft it should be rounded over to form a bead as shown in sketch. The pipe should be opened sufficiently to allow the spigot end of the next length to enter about half an inch from the top of the bead.

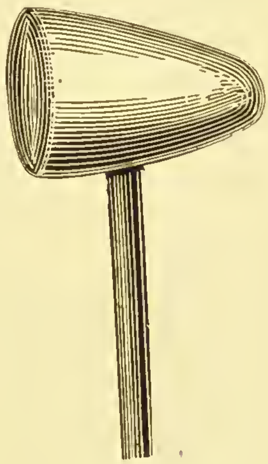

FIG. 135.

The spigot end should be shaved about an inch and a half long and tinned before it is fixed, care being taken to prepare the end perfectly square, and properly rounded with the turnpin, so that it is made to fit in the socket and no spaces for solder to fall through. The tafted edge should, of course, be shaved before the spigot is placed in it, if it is not already tinned before it left the bench. It is very rarely that this is done, although it would undoubtedly be a good plan to do it in all cases, as the tafting would not materially injure the tinning if it is done carefully.

Tinning ends on the bench is thought by some persons to be unnecessary and a waste of time, but it must be

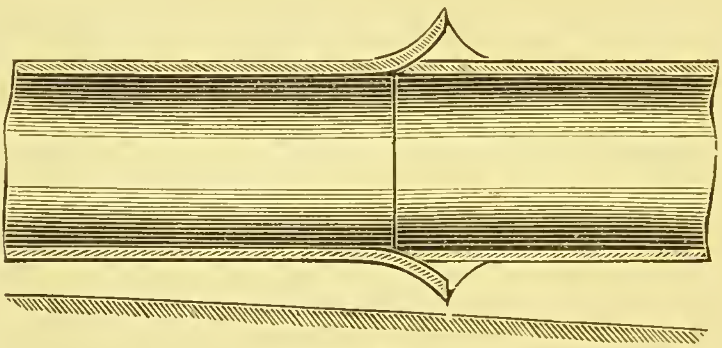

Fig. 136.

remembered that joints, especially on large pipes, have to be fixed several days sometimes before they are wiped; therefore if they are only shaved when they are prepared, the shaved surface would in many cases be utterly useless, and would need shaving again, particularly in new buildings where mortar and dirt are falling about; and in the case of block joints it would be worse than upright joints, because the flat surface of the collar would catch all the matters that fall, and make the tinning, when the joint is wiped, all but impossible, if it is not cleaned off and shaved again; and one could not possibly shave a block joint in its place and make it as reliable as it would be if it

was tinned on the bench where the pipe is prepared for fixing.

When the joint is all ready for wiping, have the solder a moderate heat and splash it on quickly, then with a clean iron well warm it up and make sure that it is well tinned, and wipe it at each side from back to front, at which point finish with a clean wipe off. It will, no doubt, seem rather superfluous to some to advise the use of an iron to warm up the solder and make sure of the tinning; but, as a matter of fact, the advice is very often more necessary in the case of block joints than it is with regard to ordinary upright joints. I have seen block joints where the solder has never been tinned to the flange or the taft, although the joints have seemed to be fairly well wiped. The cause of this is the solder has been splashed on so slovenly that the first covering of solder that is splashed on the flange has not been re-melted by subsequent splashings. The first layer of solder is, of course, cooled by its contact with the cold lead flange before any tinning takes place, and as the rest of the solder is not splashed on quick enough to fuse the lower layers, the result is a joint wiped fair at the top, but an absolute failure at the most particular place that forms the joint. In such cases as these, an iron is indispensable, as it is the best means for making the tinning a certainty, and rendering the joint sound and perfect in every particular.


FIG. 137.

Of course one does not mean to say that a block joint cannot be made perfectly sound without the use of an iron, because that would be far from the truth, and not at all reasonable if the solder is splashed on in such a manner as to thoroughly

heat the whole of the solder on the joint, and this can be done by continually manipulating it with the splasher until the whole of the solder is of the same consistency. Then if the plumber is quick, he can wipe it round without any difficulty. But my object is to point out as clearly as possible the many common faults that occur in joint-wiping, and show the causes that lead to those faults. It must also be borne in mind that taft joints are very frequently made solely for the purpose of convenience, because they are not so difficult to make as ordinary upright joints. Men who cannot wipe an upright joint can make a taft joint, or at least they think they can; but it very often happens that when a man has not had sufficient experience to make a round joint, he at the same time has not learnt the theory of soldering to the extent that is necessary to make even a flange joint properly.

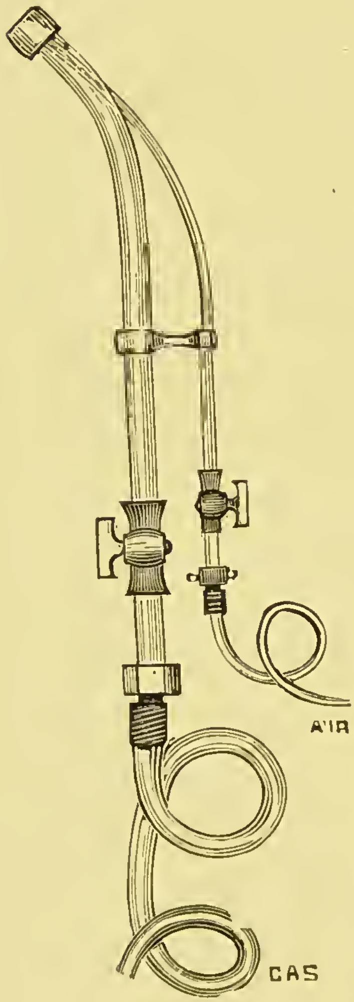

Fig. 138.

Flange joints are also used on horizontal pipes sometimes; in fact, in some cases they are absolutely necessary, for they can be made in positions where ordinary underhand joints would be all but impossible. Fig. 136 is a sketch of a case in point. A horizontal joint has to be made close down on a surface that could not be cut away; the space from the bottom of the pipe was not more than an inch. Now it would be quite

impossible to get the hand with an underhand cloth in it under the pipe in the ordinary way for wiping an underhand joint, but by forming a simple flange joint it was made without much difficulty. In this case the flange is formed out of the socket end of the pipe by opening it with the turnpin and mallet. As these joints have to be made in very awkward places, it is much the best plan to tin the inside of the socket as soon as it is shaved. This can be done with the solder from the pot by pouring or splashing it on, and wiping the surplus off with a small cloth. Some do the tinning with a copper-bit, and others by means of a blow-pipe with a gas flame, that is when it is obtainable. If the joint could be prepared on the bench there would, of course, be no difficulty about the tinning, but we are supposing that the socket end, as was the case of the joint used as an illustration, has to be prepared in its place, therefore it is necessary to use other means than those available under ordinary circumstances. When the spigot end, after being soiled and shaved, has been fixed in its place, the solder can be splashed round the joint with an iron splasher. As soon as any solder falls under the joint, it should be removed at once with the splasher, or the mate should do it with a stick, so as to prevent an accumulation of solder at the bottom, because if this is not done it would be very difficult to move it when the cloth is used for wiping. When a good heat has been produced, a small iron should be used, and the wiping started from the bottom, so as to get the most awkward part done first. If the space under the joint is so small that the cloth cannot be used with the fingers, the difficulty can be got over by using what is called a " cat's paw ". This consists of a piece of stick with a small cloth fastened to the end of it, and which is very useful in cases where the fingers cannot be used. Fig. 137 is a sketch of a cloth of this kind.

Now with regard to the use of irons to this style of joint, and to others more awkward still, it very often happens that there is not room enough for an iron of a useful size to pass round it, and as an iron, or something equivalent to it, is absolutely necessary in most cases, there are many plumbers now who make use of a gas blow-pipe, both for tinning and for assisting in keeping up the heat during the wiping. Fig. 138 shows a blow-pipe that is being largely used for this kind of work; in fact, many are making use of them in all cases where an iron would otherwise be necessary; but they can only be used where a supply of gas is accessible. Where there is no gas, other kinds of blow-pipes are used, some of which will be noticed later on. The blow-pipe, Fig. 138, consists of a piece of half-inch brass tube with a nozzle on the end for a burner, and a small gas cock on the other for regulating the supply of gas. The air tube is passed through the back of the bent gas tube, and continued to within an eighth of an inch of the end of the nozzle, where it is arranged exactly in the centre. A small cock can also be fixed on the other end to regulate the air supply. This is not always necessary when the air is supplied by the mouth, but if a bellows is used to supply the air, the cock cannot very well be dispensed with.

# CHAPTER XXIV.

## BLOCK JOINTS (*Continued*).

THE importance of properly constructed joints on soil or other pipes that are in direct communication with drains, cannot be too often insisted upon. To some, doubtless, it seems superfluous in these days of sanitary reform, to show in detail, and describe fully, such a simple arrangement as a block joint to a soil pipe; but the fact remains that if there is an easy way of getting over a joint, so that it will have the same appearance as a joint made in a more reliable manner, but requiring probably a little more care and labour in the first instance, there are so many persons who will do it in the way which gives the least trouble, while they are utterly regardless of the consequences; and as the block joint admits of more carelessness and scamping than the ordinary round joint, both as regards the preparation and the wiping, it is therefore very important to point out its weaknesses, and strongly advise the adoption of the more reliable methods.

The commonest fault of taft joints is shown at Fig. 139 A. The principal cause of this is, as I have already mentioned, on account of the taft being hammered down too tight and made sharp on the angle. This subject calls to mind a large public building in London where the slop sink wastes were fixed with block joints, and a great many of them were made as above described. Not very long after the job was finished these joints began to break away; or, rather, not the joints exactly, but the pipe becomes detached from the

edge of the taft, and so regular is the fracture as to make one doubt sometimes that it has not been partly cut through with a saw or some other instrument.

Another result of carelessly made taft joints is, the taft drawing out from under the solder as shown at Fig. 139 B. This may appear almost incredible to some, but it is nevertheless a fact, and has very often occurred when waste pipes have been used for the discharge of hot water from baths, sinks, etc. Now the cause of this defect is obvious. It is very evident that in most cases the taft has not been turned wide enough; in addition to this, the shaving was very carelessly done; it is therefore probable that the solder was never properly tinned to the taft. And sometimes when the taft is a fair width and is shaved as it should be, there is not sufficient heat applied to thoroughly sweat the solder round the taft so as to tin the edges effectually.

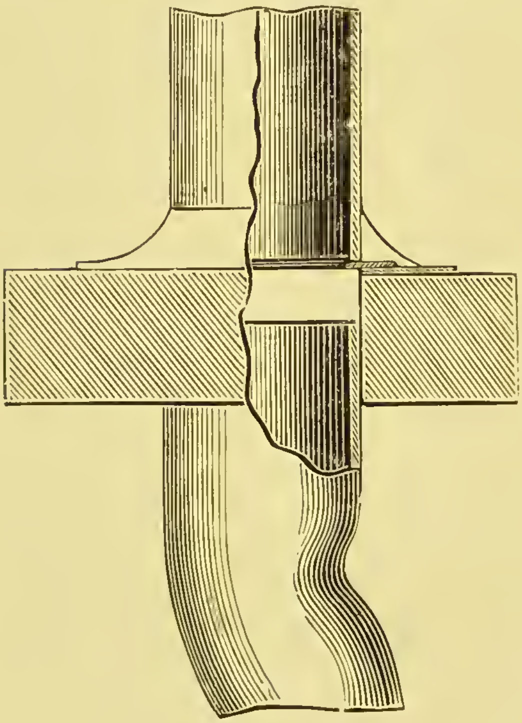

FIG. 139 A.

There are some who maintain that no matter what kind of block joint is made, where there is much expansion and contraction in the pipe, it is absolutely certain to break away from the joints first. I do not consider that this is always the case, because it may very often be observed that when the block joints are made in a proper manner, the pipe, if it

breaks at all, will buckle first between the joints, and after a time show a fracture, which can be repaired without much difficulty.

What is undoubtedly the best form of taft joint on a block is shown at Fig. 140. The block, as will be seen, is countersunk considerably; a tinned flange is worked down into this; the end of the pipe is then opened with a turnpin, and dressed close to the countersinking of the block. It is not necessary to turn a bead in this case, because there is no sharp edge to turn over. When a joint is made on this principle, and an iron or a blow-pipe flame is used to enable the shaving to become well tinned while the wiping is in progress, it is one of the best joints that it is possible to make. There is one disadvantage that some will no doubt object to, and that is, it is likely to take rather more solder than the flat taft joint. But if the shaving at the top edge of the soldering is not made to stand too much above the block, and the cloth is well pressed into the solder when it is wiped, it is not necessary to use but little, if any, more solder than would be required for the flat taft joint. Even if a little more solder is used, it must be remembered that block joints form a substantial fixing for the pipe; it is therefore not necessary to use the ordinary amount of solder

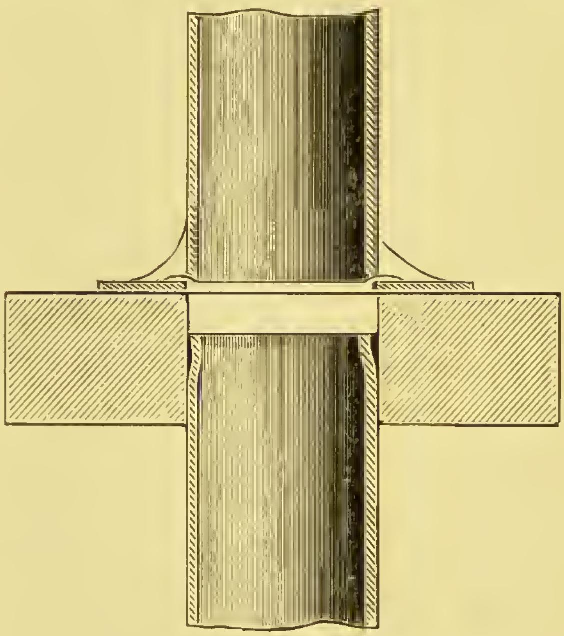

Fig. 139 b.

for tacks as would be the case if block joints were not used, so that a little extra solder can be well afforded in a good block joint.

This brings us to another kind of block joint, as shown at Fig. 141. On referring to the sketch, it will be seen that the block is formed in the same manner as the previous

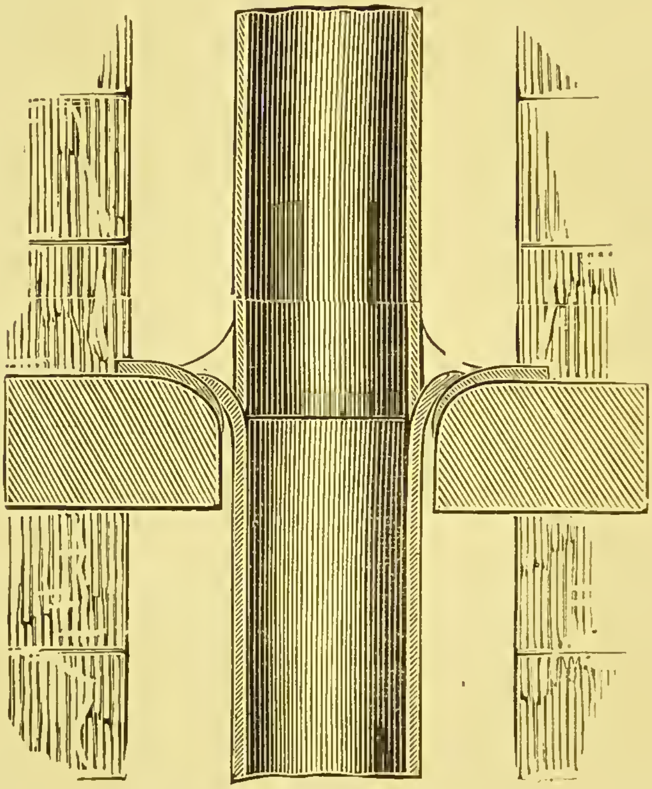

FIG. 140.

one; but instead of the joint being made on the taft principle, it is a kind of round joint and block joint combined. The flange is made to fit tight round the socket end of the pipe; at the same time it is countersunk to the shape of the block.

It is much the best plan when preparing these flanges to cut the hole much smaller than the diameter of the pipe, so

that the edge can be turned up about a quarter of an inch, as shown in the sketch. This enables the plumber to work the edge tight round the pipe, and thus prevent the solder running through when the joint is being wiped.

If the edge is not turned up it will be found very difficult to get the edge close, because it would be necessary to work it close from the underneath side; any attempt at closing it from the top would, of course, make it worse.

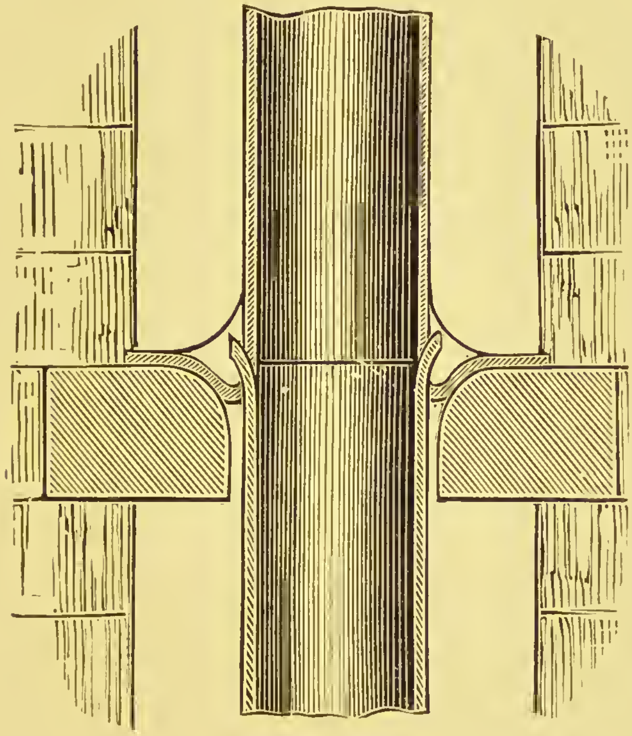

Fig. 141.

The socket end of the pipe should stand up through the flange about an inch and a quarter, and the spigot should be prepared and fitted as if it were for an ordinary round joint. The only exception is, the shaving must not be quite so long, or else the joint will stand so much above the block and make it look ugly, besides not being so handy to wipe.

The flange and the ends of the pipe should, of course, be prepared and tinned on the bench, the socket end in the

case of hot water wastes being tinned about half an inch inside. The spigot should also socket into it a corresponding depth, so as to make sure of the joint by the solder sweating into it. Now, before proceeding further, it will be well to make a few remarks about the latter point with regard to preparation of a socket end of a waste or soil pipe. I suppose there is no trade in which there is more difference of opinion than there is among plumbers respecting the details of their work. Some will do a thing one way, and some another, and they will argue in favour of their own particular idea, and hold to it with a tenacity that some would doubtless say was worthy of a better cause. One of these little debatable matters is the question whether the socket end of a soil or waste pipe should be tinned inside or not. Of course there may be some communities where the subject is finally settled, and no question is raised as to the necessity of such a thing; but among those whom I have had to do with there is much difference of opinion on the subject. There are many plumbers who insist upon having every socket end for every kind of joint tinned inside as far as the spigot end enters. They also will have the socket left open when the joint is made either on pipes that have to withstand a pressure of water, like a rising main, or on a pipe that simply takes a discharge, like a soil or waste pipe. They hold that what is right in one case must be carried out in every other, no matter what the circumstances are. On the other hand, there are more plumbers who say that the socket should be tinned and left open in the case of joints under pressure, so that the solder can sweat into it, as has already been explained in previous chapters. But in the case of pipes in which there is no considerable pressure, they think it is not necessary to tin inside and leave the socket open; and as the larger kinds of pipes that are used for soil and waste pipes are much thinner than those used

for main and service pipes, it is thought to be much the best plan to not only close the edge of the socket up, but to burr the edge in also with the point of the compasses, or some other sharp point, so that when the hot solder is applied the sudden expansion shall not cause the socket to open and allow the solder to run through to the inside of the pipe, which in the case of soil pipes is a very important matter. Others do not consider it necessary to tin the insides of the sockets in any case, and are content to trust to the outside solder for a sound joint under any circumstances. My own opinion about the matter is this. In the case of service and rising mains there can be no question about the matter; my reasons why it should be done have already been given when writing on the subject of joints on smaller pipes. Then with regard to joints on waste pipes that have hot water discharged down them, I have no hesitation in stating that the same argument holds good, at any rate to a very large extent, as that used with regard to joints on hot water service pipes. In fact, I have known cases where a similar action has occurred as that mentioned respecting the eating through of joints on hot water services. In one instance a two-inch upright joint on a hot water waste was eaten through by the corrosive action of the water, assisted by the expansion and contraction produced by the sudden changes of temperature in the pipe.

It may, perhaps, be said that the joint was broken before it was properly set, directly after the wiping, as, of course, many are. But if this had been the case, it would have shown the fracture soon after it was used; as a matter of fact, it was more than a year after the water from a bath had been continually running down it. There is no doubt, in my mind, that the cause of it was that the ends were carelessly prepared and socketed, without being tinned inside, and the joint was wiped rather light without the aid of an iron.

The consequence was, the solder being porous, it absorbed enough water to produce oxidation, which very quickly is turned into a carbonate, or, in other words, the joint was thoroughly eaten away with corrosion. Some will, no doubt, take exception to this line of reasoning, and say, that as it is generally observed that corrosion nearly always commences where the lead and solder join, it must therefore be wrong to let the solder sweat in between the two ends of the pipes, so that it becomes more exposed to the action of the water. Well, certainly, this idea is logical, but to my mind it is one of those matters which suggest the saying, that practice does not always square with theory, for no one can point to a properly-made joint as I have described, that could be eaten through under ordinary circumstances.

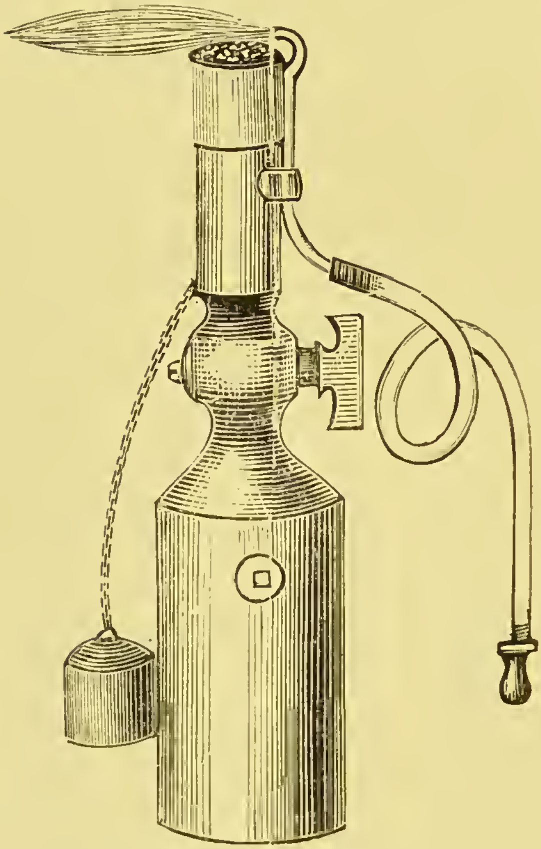

Fig. 142.

There is one thing about the tinned socket: that is, if the ends are closely fitted, there is so little of the tinned surface exposed, that the conditions can hardly be compared to the action of water on the soldering in leaden cisterns, where this action is seen more than anywhere else.

It is not only ordinary round joints that are liable to the

action above mentioned, but I have seen taft joints that have been broken nearly all round by apparently the same cause. Generally they have been wiped very bare, and have shown the edge of the taft through the solder. As they are often prepared and fitted as shown at Fig. 138, it is no wonder that they have not remained sound as long as the pipe they are made on. But if they were made as shown at Fig. 140, it would matter very little whether they were wiped light or heavy, for the solder that flows into the socket is quite sufficient to make a sound and reliable joint.

Fig. 142 is a sketch of another kind of blow lamp that is very useful where gas cannot be obtained for the one shown in the previous chapter. The present one consists of a brass chamber at the bottom, for the purpose of containing a reserve of methylated spirit, which is kept closed by means of the cock attached. The upper part is a hollow tube which is filled with the cotton that is generally used for spirit lamps. There is a loose socket fitted to the top of the tube; this can be slipped up or down to regulate the size of the flame. The air-tube consists of a piece of small brass pipe fastened to the upper tube with a clip, either soldered or riveted. When the lamp is required the tap is turned on, while it is held upside down until the cotton is saturated with spirit; it is not necessary to turn the tap off while the lamp is alight, so long as it is not turned upside down. The principal use of the tap is to shut in the spirit when it is not in use. The spirit is put into the cylinder by removing the small screw cap as shown in the sketch. These lamps are very useful, in many instances, where irons are not convenient.

# CHAPTER XXV.

## BLOCK FIXINGS.

IN the preceding chapters we were considering the different kinds of block and taft joints, and the most approved methods of making them. A few years ago these joints were in great favour; they were considered the very perfection of joints, and as it was the rule to fix soil pipes inside the buildings in chases or angles, where there were good fixings for the blocks, it was a rare thing to see a soil pipe fixed in any other way; and as the blocks were generally made large enough to reach from one side of the chase to the other, it became customary to make the joints on all other pipes in the same chase in a similar manner, whether they were wastes, rising mains, or services.

When the smaller pipes are fixed through the blocks, it is, of course, not necessary to make joints so close together as those on the soil pipe; in fact, it is best not to make the joints on the mains and services on the blocks at all, but rather to let the block form a fixing only, by means of a flange wiped round the pipe and resting on the block. The joints can then be made upright in the ordinary manner in positions most suitable to the lengths of pipe that are being fixed.

And, as it would be a very awkward matter to thread lengths of pipe through the holes in the blocks, it was found much more convenient to have the blocks sawn in two, so that one half of the blocks could be fixed, and the pipes put in their place before the other half was placed in its position

in front of the pipes. The two parts of the block are fastened together with bolts and nuts, or coach screws. Fig. 143 shows the plan, and Fig. 144 the front view of a block as above described.

It is not absolutely necessary to fix blocks across the whole width of the chase, if it is desired to fix the soil pipe on blocks and the smaller pipes with round joints and tacks. Blocks can be made as shown in Fig. 145. If they have a bearing at the side and back, as shown, it is quite sufficient for a good fixing. Some blocks are made, as shown at Fig. 146, with a fixing at the back only, and the front angles

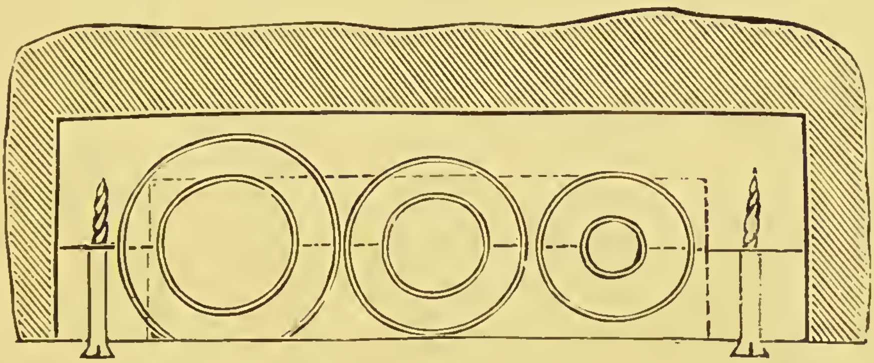

FIG. 143.

either rounded off or left square. When blocks are fixed in this manner, it is, of course, necessary to see that they are well wedged in the brickwork, and made good with cement. It is also a good plan to have them made with a dovetail edge, for fixing in the wall, because there is a probability that the expansion and contraction of the pipe will cause them to work loose and draw out, especially if the block is not thoroughly dry when it is fixed.

Blocks for a soil pipe fixed in an angle are made as shown at Fig. 147. The front of the block forms a good fixing for an angle casing, as, indeed, they do in ordinary square chases like that shown at Fig. 143.

We will now pass on to the consideration of some other kinds of joints on large pipes. Of late years the plan of fixing soil pipes inside buildings is being very generally condemned. It would be out of place at this point to discuss the advantages and disadvantages of inside soil pipes, as that will have to be a subject by itself.

But as the outside soil pipe is now recommended as the most sanitary method to adopt, the block joint is therefore very rapidly going out of date, as it would not be at all

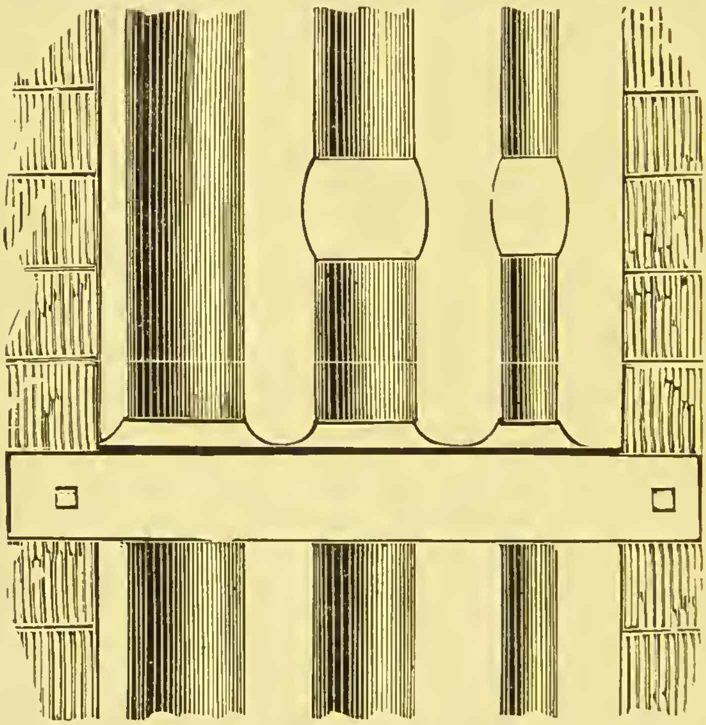

Fig. 144.

suitable on an external wall. Chases on the outside walls could certainly be arranged if it was required, and blocks could be fixed in the same manner as they are inside, but this is rarely if ever done. The great objection, of course, would be the exposure of the wooden blocks to the weather, although this objection could be met by using stone blocks as is sometimes the case inside chases; but after all there would

be no advantage obtained that would make them in any way more desirable than the ordinary round joints and tacks.

With regard to the ordinary round upright joints on soil and other large pipes, as far as reliability, convenience, and neatness are concerned, that is, where no ornamental effect is required, they are undoubtedly the very best joints that are made.

Much, of course, depends upon the shape and size of the joints. There is considerable difference of opinion with regard to the length and general proportions of a soil pipe joint. In some parts, especially in the North of England, and also in Scotland, they are generally made something like those shown at Fig. 148. The joint C only consists of a copper-bit seam round the joint. This kind of joint is very often made on soil pipes, but only where it can be made horizontally, and where the pipe can be rolled over in a convenient manner for using the copper-bit. The plumbers in the North are very skilful in this kind of work, they can run a seam round a pipe almost as clean as it can be floated on a flat surface; not that it is to be recommended for soil pipe joints, for it seems out of all proportion to the strength required, especially where such joints are made on the same pipe as that marked B, Fig. 148. Before bends were made on the lengths of pipe with the use of dummies—and there are some parts of England where they are not made by such means now—it was the custom to make the bends with one or two pieces of sheet lead, and solder the seams with the copper-bit.

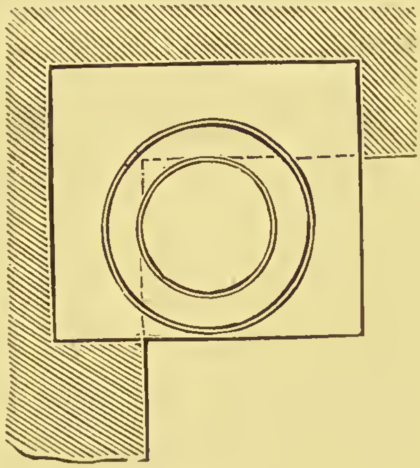

Fig. 145.

These bends were made short for convenience, with the result that they had to be soldered to the lengths, so that each bend involved two joints. These two joints were generally made on a bench with the copper-bit seam as shown at C, then the other joints for joining the lengths were wiped like that marked A or B, so that when the work was fixed it looked quite strange to see one joint about four to six times the length and twelve times the bulk of the other. It is not my intention to dispute the fact that the copper-bit joint answered the purpose, at any rate for a time, as well as the wiped joint, but the proper view of the matter is this—if a copper-bit seam is good enough in the one case, why not in the other? If it is considered safe and substantial to give a certain amount of strength in one place, why withhold it in another place, where the conditions are the same? Then see how inappropriate it looks to have a joint like C at one point and another like B a few feet from it.

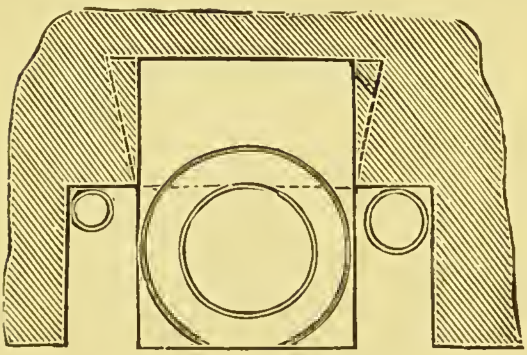

FIG. 146.

The above style of work is referred to in the past tense, but there are several parts of England and Scotland where it is done to-day, although there is no doubt that the introduction of patent drawn pipe is rapidly doing away with the copper-bit seam style of work, as it is generally considered unsuitable for good substantial sanitary plumbing, like that demanded of plumbers at the present time.

My opinion has already been expressed on the evils attending the copper-bit system of plumbing, and its demoralising effects on the trade, therefore it is unnecessary

for me to repeat my remarks on that subject. But there is another view of the matter that it may be well to call attention to, and that is the want of uniformity that is so conspicuous on work in which various styles of soldering are introduced, with no other object than the expenditure of as little materials as possible, combined with a low standard of workmanship. As to skilful workmanship and uniformity in carrying out the work, these, as a rule, are only secondary considerations. So long as the work can be "got over" as easily as possible, it matters little how it is done or what it looks like to many whose end and aim are certainly not the elevation of the craft, whatever else they might be.

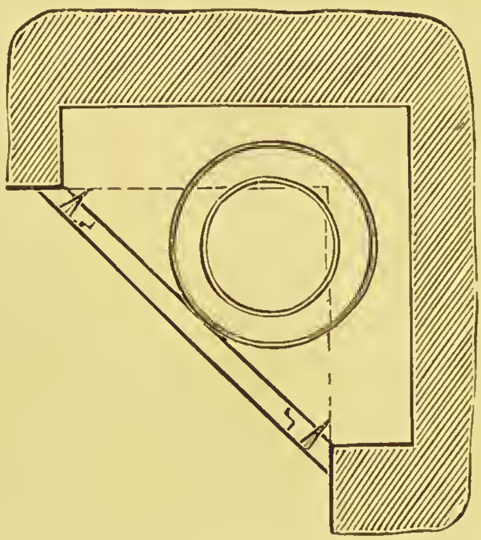

Fig. 147.

Of course one is well aware that there are some places where the copper-bit is used on soil pipe work because it is the usual custom to do so. The plumbers have been taught this style of work in their apprenticeship, and they do it as a matter of course. Fortunately a better style of work is rapidly becoming popular; architects and engineers are recognising the superiority of the more substantial way of executing modern plumbing work.

But to return to the subject of upright joints on soil pipes. As regards the length of such joints, much depends upon the taste or fancy of the person who decides what length they shall be. The question is, shall the outline of pipe be interrupted by an abrupt angle and a shapeless excrescence as that shown at Fig. 148, or does it not look better to let

the joint form easy curves in the outline more like an ornament than an ugliness? Short joints, as a rule, do not admit of easy curves, but are very often stumpy and unsightly.

Fig. 149 is a sketch of two joints on four inch pipes about three inches and a half long. If they are made about this length, it is not necessary to use an unusual amount of solder; in fact, they are often made with less solder than is

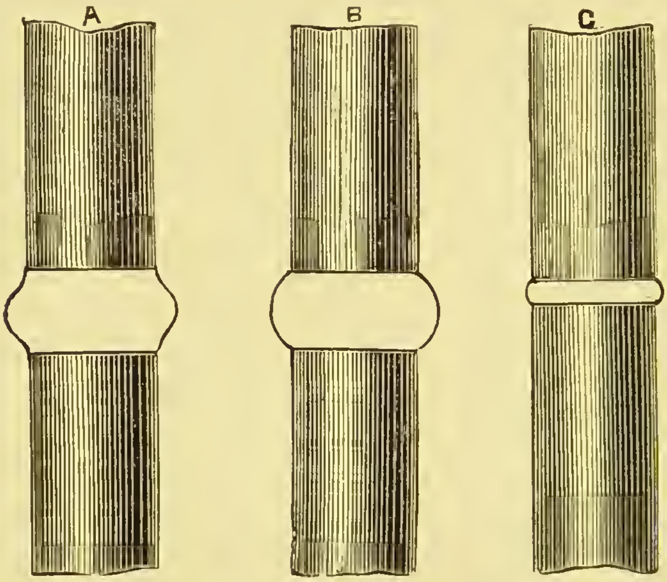


FIG. 148.

used on most short joints—and if a little more solder should be required it is worth the extra for the improved appearance.

In the preparation of these joints, it is not necessary to tin the inside of the socket end as advised in the case of services and hot water wastes. All that is necessary is to soil and shave the outsides only, and tin them on the bench in the ordinary way. When the ends are fixed for wiping, close the socket end tight up to the spigot, and burr it close with the point of the compasses. This is much the best plan in the case of soil pipe joints, because the lead being

much thinner in proportion to the size of the pipe than it is in services and heavy waste pipes, there is a probability of the edge of the pipe opening with the sudden splashing on of the hot solder. If this should take place it scarcely ever closes up again, especially if a drop of solder has found its way through the socket to the inside of the pipe; and as the solder gets warmer by the continued splashing on, so the first drop is followed by several others, until the wiping is finished and the solder is set. Although all joints should be carefully fitted so as to prevent the solder running through, yet in the case of services and waste pipes it is not so detrimental to their use as it is in soil pipes. These should be as smooth as possible and free from all obstructions, so as to prevent them being fouled by the solid matters, hair, etc., that are continually passing down them. Then the open socket that was insisted upon in pipes conveying water under pressure, is not absolutely necessary in a soil pipe joint, because if they are properly ventilated the pressure they are subjected to is hardly worth taking into consideration. Therefore the solder on a good upright joint is quite sufficient for all practical purposes. It may be thought that if it is best to close the edges of an upright joint as shown at Fig. 149 it would also be proper in the case of block joints, or, at any rate, that were opened to the same defect; but as the socket end of the block joint is either beaded or tafted, this forms a stiffening to the edge, and prevents the opening of

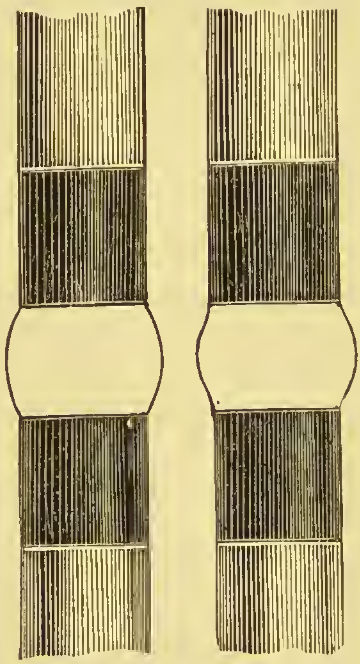

FIG. 149.

the socket which is liable to take place in ordinary upright round joints.

As regards the block joint, Fig. 141, in the previous chapter, it is necessarily open to the same objection as the open socket of an upright joint, but the reason why the socket is left open in this case is for the purpose of getting hold of a longer length of the spigot end than would be possible if the socket was closed up, whereas if it was shaved longer it would make the joint an unusual height above the block, and take an enormous amount of solder. For my part, however, the open taft is the better joint of the two, and is not open to so many objections; and although it has, by reason of its form, the open socket, yet, owing to the stiffening of the edge by the taft, it is, as already stated, the best joint of its kind.

## CHAPTER XXVI.

### ASTRAGAL JOINTS—PIPE FIXINGS.

SINCE it has become the fashion to fix soil pipes on external walls instead of placing them in inside chases or angles, much ingenuity has been exercised in producing joints which are considered less objectionable in appearance than the ordinary round joint, and which can be used in connection with astragals and fixings of a more ornamental character than the old style of sheet lead tacks that answer the purpose so well in so far as strength and neatness are concerned. Of course most plumbers look with unfeigned admiration upon a neat clean joint with the back soil above and below it unscratched, and made waterproof by being well saturated with touch; but as most persons do not look upon it from a plumber's point of view, and often are puzzled as to why the soil is left on at all, it is therefore necessary to arrange something that will suit the general public or rather their advisers, the architects, rather than to continue to adopt the old style simply because plumbers like the appearance of the contrast between the silvery solder and the black soil.

I know one case where the architect had the soil washed off from the joints and tacks on some stacks of soil pipe and had the joints painted a dark lead colour. When the soil had been washed off and the joints well cleaned, in my opinion it improved the appearance of the pipes—they certainly looked neat and not at all conspicuous; but when the joints were painted with the dark lead colour, the effect

was strange and far from agreeable. However, it pleased the gentleman who ordered it, therefore the plumber had to swallow his objections and be contented.

In many cases soil pipes have to be arranged to match rain-water pipes, with the idea of disguising their use as soil pipes; but why this should be, one is at a loss to understand. As a soil pipe is of quite as much importance as a rain-water pipe, if not more so, and as they are certainly required more substantial, the joint and fixings should also be much more secure; consequently, in my opinion they should have a distinct character, and no means used to make them look like rain-water pipes.

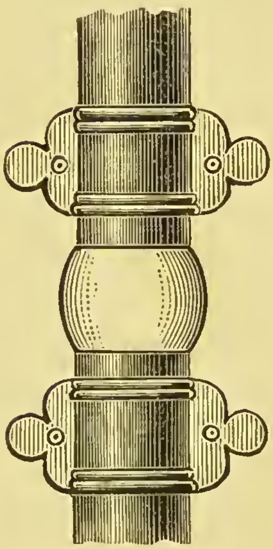

FIG. 150.

I remember hearing a celebrated architect say that anything that is really necessary in a building which has been fixed for a distinct use, while it should be made as much as possible to harmonise with the character of the building, should never be made to look like something different to what it really is; in other words, nothing should appear to be what it is not. Of course this rule is being broken every day in nearly every branch of the building trade; but still there can be no doubt that it is a good and true principle to work upon, and one that plumbers especially should try to enforce by every means in their power. There are too many shams in the plumbing trade; the rule is to hide the work as much as possible, to put it in a chase behind a casing, bury it in a wall, under a floor, or in a roof anywhere to get out of sight. That plumbers are in a very large measure responsible for this state of things admits of no doubt, owing to the unreasonable and scamping methods

that have been prevalent among those who profess at any rate to be plumbers.

As to the materials that plumbers have to do their work with, there is scope for such a variety of treatment that no excuse can be made in that direction either as regards strength, durability, or ornamentation.

Some, while retaining the ordinary round joint, have

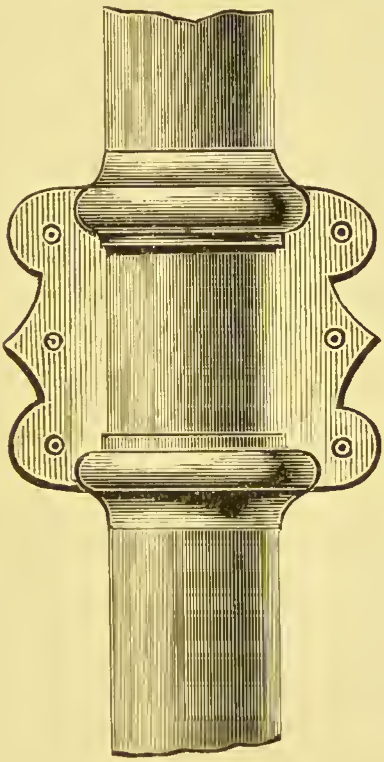

FIG. 151.

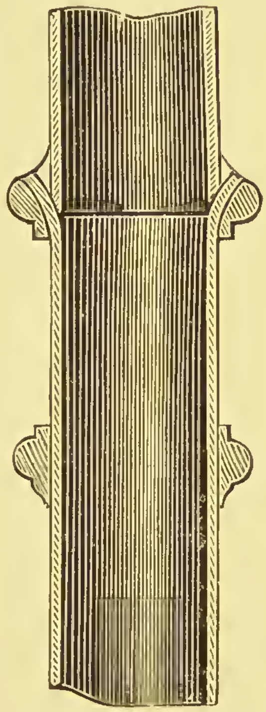

FIG. 152.

arranged some astragals and ornamental ears, so that the whole should form a strong astragal and joint combined. If soil pipes are fixed in this manner, it is best to use the pipe in six feet lengths, instead of ten, as they are usually fixed, otherwise a single pair of ears would be required at the centre of the lengths, which would look rather odd, although many people would not consider them objectionable. When six feet lengths are used, each joint and fixing

is identical with the others, giving a more uniform effect. Fig. 150 is a sketch of this kind of astragal. The proportions of the joint and ears can be arranged to suit the taste of the architect, or to any particular design. Another kind of astragal joint is shown at Fig. 151; a section of it is also shown at Fig. 152. Instead of a round joint of the ordinary kind, a flange or socket joint is made so as to form part of an astragal. This style of joint is most in favour where the soil pipe has to be fixed on the principal front of a house near to other ornamental pipe, or where they are required to form an architectural feature in the elevation. In preparing the ends of the pipe for this kind of joint, care should be taken to properly square both the socket and spigot ends so that they fit together true and even. The socket end should be opened sufficient to allow the spigot to enter about an inch and a quarter, and the inside tinned a corresponding depth. The spigot should be shaved and tinned about two inches long, or of such a length as will allow the joint to be wiped to match the lower member of the bottom astragal.

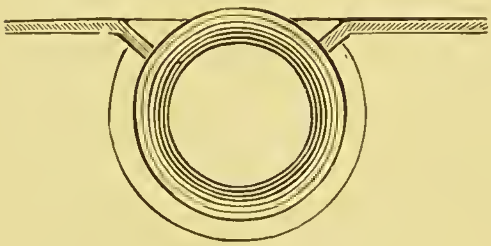

FIG. 153.

The astragals are generally cast in straight lengths about a foot long; these are bent on a wooden mandrel the same size as the soil pipe, and after being cut and fitted so that the ornamental ears fit close to the ends of the astragals, as shown at Fig. 153, they are then soldered to the pipe either by sweating fine solder in between the ends of the astragals and the pipe, or by soldering them all round the pipe, although in my opinion the latter is not necessary.

If they are well sweated with a pointed cooper-bit or a blowpipe, about an inch down from the end, the soldering

all round the front can well be dispensed with. But where it is thought necessary to solder the astragal all round, it is much the best plan to sweat them on with a gas blowpipe, similar to that shown at Fig. 138 in a previous chapter. If they are soldered in this manner it is only necessary to shave and tin the two surfaces that come together, so that when the soldering is done, there is no surplus solder to clean off, thus doing away with much waste of time and labour, and making a better job of it altogether. The next thing to do is to solder on the ears or ornamental tacks. These are generally cut out of thick sheet lead to the pattern required, or if there are many wanted, a mould is made either of lead or gun-metal, in which to cast them. Some of the large firms have lately had some moulds made, to one or more patterns, and of various sizes for the different size pipes that are used, either on external walls or on the face of internal walls. After soiling, shaving, and bedding the edge of the tack as shown in section, Fig. 153, they can be wiped on in the ordinary manner by pouring on the solder until a good flowing heat is obtained, and then wiping it flush with the tack and pipe as shown. There are two or three other styles of soldering for tacks which we shall have to consider as we go on with the subject. Fig. 154 is another of what is called an astragal joint, but instead of the joint being wiped it is either floated

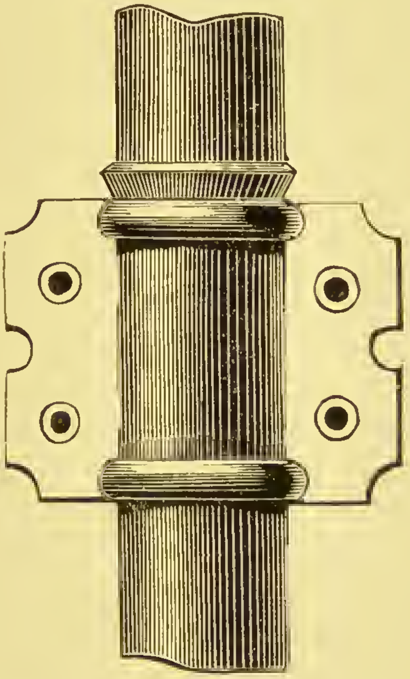

FIG. 154.

round with a large copper-bit, or else the solder is sweated in the joints by means of a blowpipe, where gas is obtainable, otherwise a blow-lamp is used similar to that shown at Fig. 155. This will be recognised by many as an apparatus that is often used by painters for burning paint off doors, etc.; to those who have not used one, perhaps a short explanation of its action will be useful. It consists principally of two chambers made of copper; the lower one is simply a lamp chamber, containing some methylated spirit in which is dipped some loose lamp cotton, the upper ends of which stand out about half an inch. The upper chamber acts as a boiler. After about half filling this boiler with the same kind of spirit as the lamp below, the cap on top is screwed in tight; this cap contains a small safety valve to prevent explosions. The lamp is then lighted. In a few minutes, the spirit in the boiler begins to evaporate, and blows through the small tube, discharging through the nozzle at the end in the form of gas. This, in addition to blowing the flame of the lamp forward, also ignites, and the two flames together form a long tongue of heat of considerable intensity and quite smokeless. The joint (Fig. 154) is prepared in a similar manner to that shown at Fig. 152; the only difference is, the socket end is not opened quite so much, and the spigot end is only tinned about a quarter of an inch higher than the top edge of the socket, with the object of hiding the joint as much as possible.

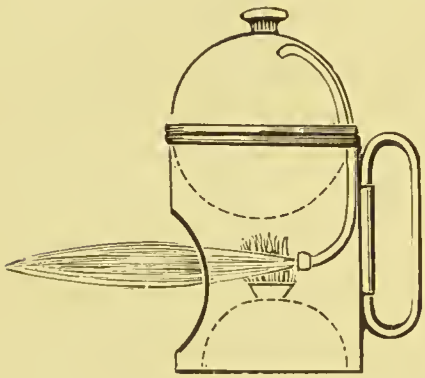

Fig. 155.

The astragals can either be cast in the form of a moulding, as in the previous instance, or if only a plain job is required, they can be made by cutting a piece of

small pipe down the centre with a saw, so as to form a plain half-round bead, as shown in the sketch. Then, to carry out the idea of using the materials that are generally to hand, without having to make moulds for casting, or where cast tacks are difficult to obtain, the tacks can be made of sheet lead, fixed with wall-hooks, and turned in in the ordinary manner. Or if round-headed nails are preferred, they can be driven in after the tack is turned; but the best plan is to drive the nails in before the tack is turned, then to cover the head with the tack and work the lead close, so that the shape of the head is shown through the finished tack. When wiping on the sheet lead tack, the soldered edge should not lie close to the end of the astragal, as advised in the case of cast tacks; but a strip of lead, the same thickness as the tack, should be laid between the end of the astragal and the edge of the tack, so as to leave room for the outside edge of the tack to come up close to the pipe when it is turned, as shown at Fig. 156. On referring to Fig. 154, it will be seen that the top astragal is shown about three-quarters of an inch below the top of the socket. This is advisable because, if the astragal was brought to the edge, it would make it more difficult to get sufficient heat directly on the joint to properly sweat the solder down to the bottom of the tinned surfaces. The astragal, being hollow, acts, to a very large extent, as a non-conductor of heat, and there is considerable danger of melting the lead before the solder is made to flow round the joint as it ought to do. But if the astragal is kept down a little way from the edge, the flame from the blow-lamp can

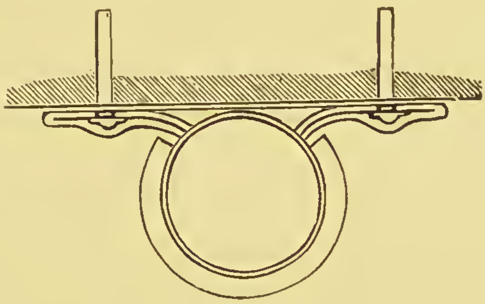

Fig. 156.

be brought to bear more directly on the joint without any difficulty. There is also another reason why the astragal should not be close to the edge of the joint, because, if it was, the tacks would have to be brought to the edge also. If this were the case, it is obvious that when the flame is directed on the back of the joint, it would be impossible to make the solder in the joint flow, before the solder on the upper ends of the tacks was melted. This, of course, would be very objectionable. In this kind of joint, the last-mentioned points are very important, because there is no body of solder to be depended on. A mere skin of solder on the top edge of the socket would be only a tinkering job ; that is why it is much the best plan to use a flame of some kind. If a copper-bit is used, it is very difficult, if not impossible, in some positions, to get up sufficient heat to flow and sweat the solder, so as to form a thorough, sound, and reliable joint.

With regard to the lamp shown at Fig. 155, it is very useful for many other purposes besides the joints just referred to. Many plumbers use them for ordinary wiped joints either to take the place of irons, or, as I have done myself, for the purpose of dispensing with both solder pot and ladle, that is, so far as the actual making of the joints is concerned. The process is as follows :—The solder is run out on a stone into strips or in the form of fine solder. When the joint is prepared in the ordinary way, the lamp is lighted, and as soon as it begins to blow, the flame is directed to the shaved surface. As there is no smoke produced, there is little fear of tarnishing the shaving, especially if touch has been properly applied before the lamp is used. A strip of solder is then held to the heated surface, until a part of the solder fuses and hangs to the pipe. This process is continued until there is sufficient solder adhering to the shaved surface to form the joint.

The lamp is then used as a substitute for an iron, with this difference, that while the lamp is blowing the joint can be wiped with the utmost leisure. In fact it seems the longer the time one is making a joint by the aid of the lamp the better it looks when finished, for the solder seems to improve by the action of the continued use of the lamp. Whereas with an iron the quicker it is finished the better.

## CHAPTER XXVII.

### LARGE BRANCH JOINTS.

THERE is another class of joints which demands special attention. We have already considered the construction of branch joints on small pipes, such as services; but those on soil pipes and waste pipes have to be arranged on quite different principles. The angle at which a branch service is joined to a main service, for instance, is of very little importance compared to that required to branches on soil pipes. In the one case, nothing but clear water passes from the main pipe to the branches, and although the resistance is considerably reduced when a branch is fixed at an obtuse angle with the flow of water in the main service, as shown at Fig. 157, yet in general practice the advantage is so small as to make it unnecessary, as a rule, to consider the resistance offered so much as the appearance of the branch or the position most suitable to fix the pipe. In the other case, the conditions are just the reverse. In the first place, the flow is from the branches to the main pipe, or at least it should be so in the arrangement of soil pipes and the branches connected with them. That it is not so in many cases is well known; for instance, Fig. 158 illustrates a serious blunder in this respect, which I saw myself in a country mansion.

Two closets were connected with one branch soil pipe by means of a horizontal piece of pipe having a right angle elbow at each end. After the discharges had passed these elbows, they had to find their way into the branch pipe in

the centre, which was connected at a right angle with the horizontal piece, as shown in the sketch. It must be obvious to any one that the result of this arrangement was the continual recurrence of stoppages, and in this particular case, instead of employing a competent man to remedy the defect, the estate carpenter was required to unstop the pipe, which he did by cutting a hole in the top and repairing it with putty or red lead cement. This, like most bad arrangements in plumbing work, led to worse botching; and as the soil pipe was an old one, and not ventilated, it was therefore a most dangerous piece of work altogether especially as it was situated very near to sleeping apartments.

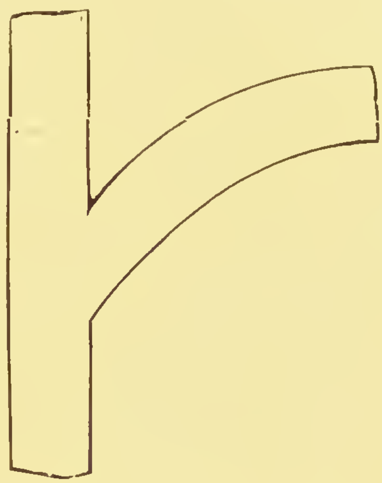

FIG. 157.

The proper and most reasonable way of remedying the defect is shown at Fig. 159. The branch should enter the other pipe at as acute an angle as possible under the circumstances, so as to give the least resistance that can possibly be obtained to the flow of the discharge; and, instead of elbows, bends should be made to an easy curve. By this means, the discharge passes away quickly, as very little obstruction is offered to its progress through the horizontal branch to the main pipe.

The next branch joint we have to consider is that connecting the horizontal pipe with the vertical. The common practice is to join the branch to the upright pipe at the same angle as the fall or inclination of the branch pipe. When large size pipes are used for this purpose the angle of the junction is of no particular importance, or, at

any rate, as compared with those made with small size soil pipes; and as the tendency in these days is to reduce the size of soil pipes to the smallest possible calibre—the advantage or disadvantage of which we shall have to consider later on—it therefore depends to a very large extent upon the arrangement and construction of the branches as to whether the smaller size soil pipes are practicable or not. Fig. 160 shows the usual style of connecting a branch with the vertical pipe; it also is very often the case that the end

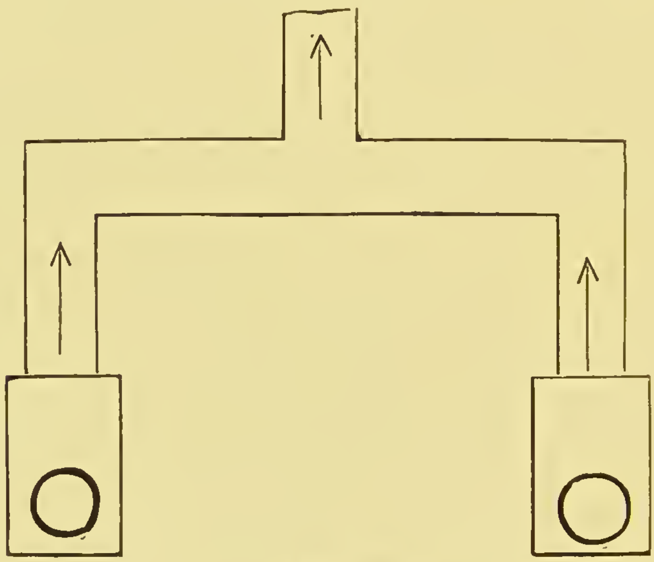

FIG. 158.

of the branch is allowed to project beyond the inside line of the vertical pipe, thus forming an obstruction to the solid matters passing down it.

But supposing a branch of this kind to be the upper one on a stack of soil pipe, what happens is this:—During a temporary failure of the water supply, either through frost or the fittings being out of order, a large quantity of paper will probably be gathered in the branch; this is sometimes formed into a solid plug, perhaps a foot long, if not the whole length of the branch. When the proper water supply

is restored, or if a large quantity of water is suddenly discharged down the closet, the accumulation of paper is driven with considerable force along the branch to the vertical pipe, where it strikes the other side opposite the branch, and remains an effectual stoppage both to the vertical pipe and the branch also. The more the pressure is brought to bear by filling the branch and closet with water, the tighter the plug becomes, and as it is the highest branch on the stack there is no pressure from above in the upright pipe to remove the obstruction. The consequence

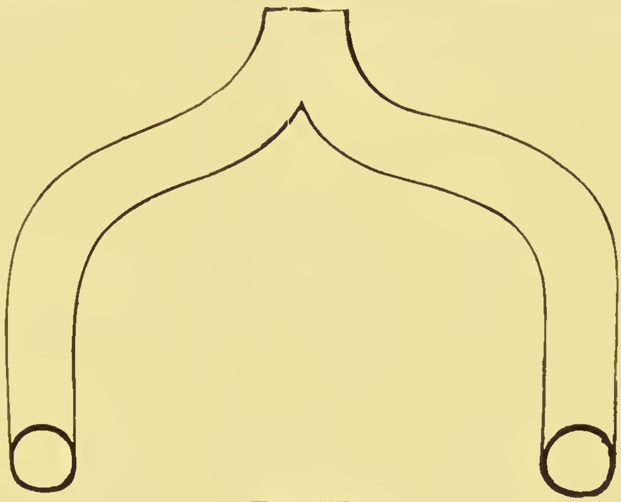

Fig. 159.

is that, if there should be no branch ventilation, all ventilation is stopped in addition to the closet being put out of use. There is another thing that, in my opinion, should be taken into consideration with regard to upper branches. If a horizontal pipe is joined to a vertical one at very nearly a right angle, it follows that the discharge from the branch pipe is very much obstructed as it enters the vertical pipe as it strikes violently the opposite side. This in most cases produces an upward splash, sometimes taking solid matter with it.

Now it is quite reasonable to suppose—in fact, cases

have occurred under similar conditions—that the splashes accumulate, being dried on after each discharge, as they are out of reach of any flushing power to remove them. After a time this action, in all probability, will partially, if not wholly, stop the pipe up. Branches on soil pipes then should be so formed as to produce as little interruption as possible to the flow of the discharges.

Fig. 161 is a sketch of a branch joint of this kind. It will be seen that before fitting the joint together, a bend is

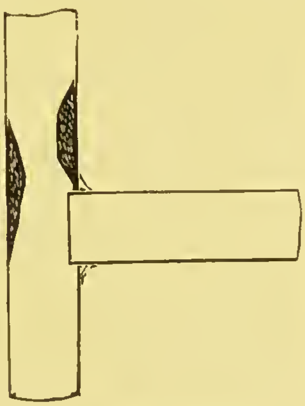

Fig. 160.

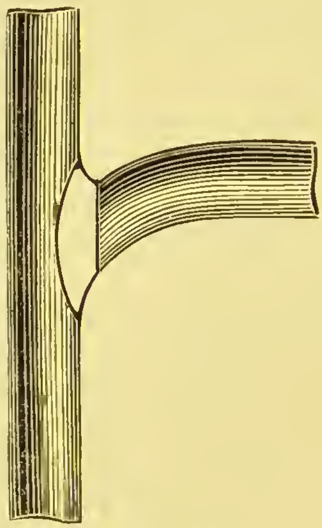

Fig. 161.

made on the end of the branch pipe to an angle of about 45°. When a joint is prepared in this manner it is of little consequence what fall is given to the other part of the branch pipe ; it may be nearly level and then work perfectly satisfactorily. Fig. 162 shows another kind of branch, joining a horizontal pipe on the top. When such a junction is found to be necessary the bend on the branch pipe should be made much longer than that joining a vertical pipe. The object should be to enter the horizontal pipe as far from the vertical line of the branch as possible, so as to ensure the

discharge from the branch pipe flowing into the horizontal pipe in the same direction as the fall. If the branch falls straight into the lower pipe, or only a short bend is made, as shown at Fig. 162, the discharge simply drops on the bottom of the horizontal pipe, with the result that a large proportion of the solid matters is washed up the higher end of the lower pipe, as shown in the sketch, while that part of the discharge that flows away is deprived of its flushing power to a very great extent, and leaves a large amount of paper on the bottom of the pipe.

Where it is possible a branch of this kind should be made in the form shown at Fig. 163. It will be seen that if a line is dropped down in continuation of the direction of the vertical pipe it will cross the horizontal pipe about six inches from the branch, thus making it impossible for the discharges to fall vertically on the bottom of the horizontal pipe, but as they fall on the bend they are directed towards the flow of the pipe with but very little check to the flushing power of the water.

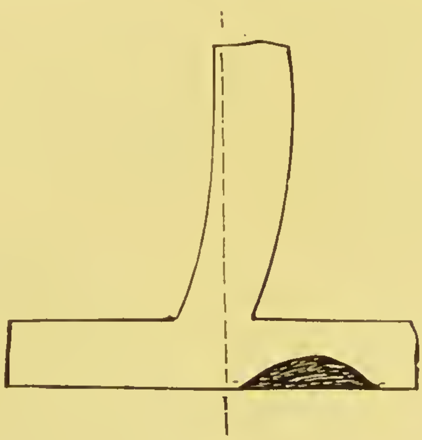

FIG. 162.

In the arrangement of branches it is important that the flushing action of the discharges should be considered very particularly, because one of the principal arguments in favour of small soil pipes is, that the discharges from closets and slop sinks are more concentrated in small pipes, and therefore have a more scouring action on the inside surfaces of the soil pipes than is the case when larger ones are used. With regard to waste pipes, such as those from baths and sinks, there is, of course, but very little solid matter to pass

through these pipes; but although there is very little danger of them stopping up with solid matter in badly-made branches, yet it is equally important that they should be so formed as to allow the waste water to pass away as rapidly as possible, so that the pipes are well scoured by every discharge.

When preparing a branch joint, say on a 4-in. main soil pipe, with a 3½-in. branch, first set it out with a chalk line on the bench or floor, with the proper fall to the branch and

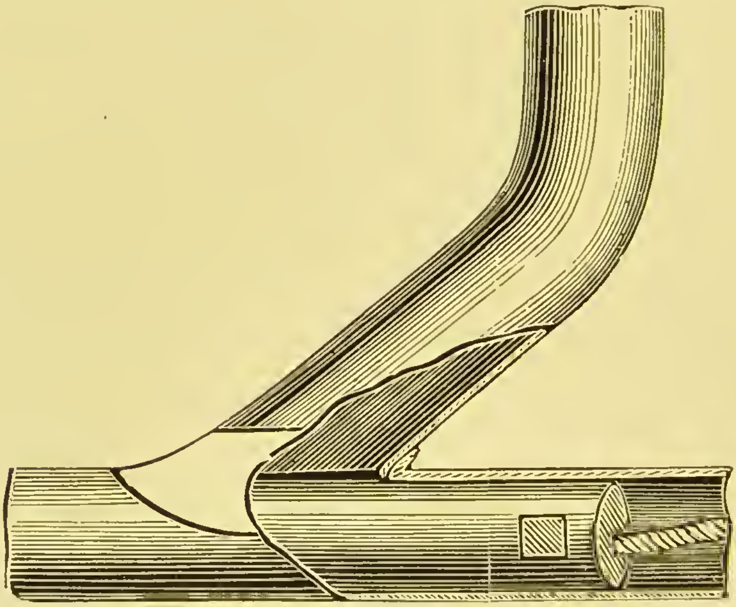

FIG. 163.

the bend required according to circumstances; then bend the end of the branch to the lines, and cut it off the right length, keeping the saw parallel to the side of the main pipe; rasp the end and soil it, after which shave it about an inch and a half long.

Now place the branch in its position against the main pipe, and mark the length of the hole required. Cut a slot in the centre, reaching about an inch from each end, and about half an inch wide. Warm it well with a gas flame or

some lighted shavings placed inside the pipe. The hole can then be opened with a large bolt and a hammer, and finished with a short dummy.

Rasp the edge of the hole perfectly level, and let it stand about three-eighths of an inch above the pipe. There are some who prepare a branch joint of this kind in the form of a mitre, by cutting the end of the branch pipe to fit the curve of the main pipe. This is a mistake. It is not only much more difficult to fit and fix for wiping, but it is also a bad job when it is done. Among other reasons, the joint

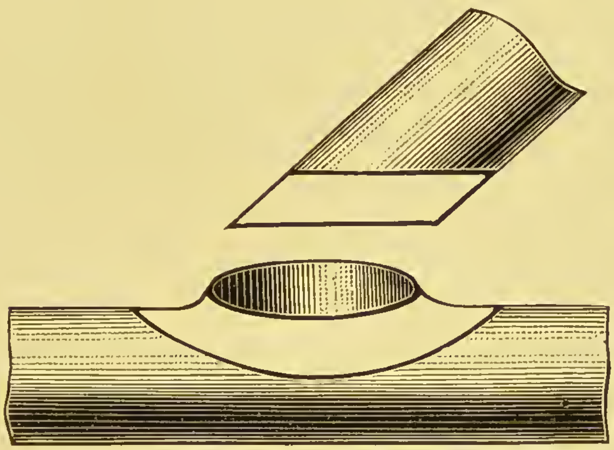

Fig. 164.

cannot be made to fit so tight as it can by being prepared in much the same manner as an upright joint, as far as the socketing is concerned. The sketch (Fig. 164) shows the two parts prepared before fixing. The shaving on the main pipe should be about an inch and a half deep on the side of the pipe, and a proportionate length at the ends of the joint. As soil pipe is comparatively thin in proportion to the size of lead pipes, it is necessary to take special precautions in fixing the parts before a joint is wiped. It sometimes happens that when a branch joint is being wiped, if the

weight of the branch is not properly supported when the solder is being splashed on and the pipe well hot, the branch will slip into the hole and half way into the main pipe, causing much trouble and inconvenience. To prevent this, the branch should be well strutted and tied firm ; and, as an extra precaution, it is a good plan to place a short mandrel in the main pipe, as shown at Fig. 163. This prevents the branch slipping down, and also keeps the lower pipe in shape while the joint is made. Before starting to make the joint, the edge of the hole should be closed tight up to the end of the branch pipe, and burred close with the point of the compasses. I have already explained that this is much the best plan to adopt when preparing soil pipe joints, as the pipe is much thinner than that used for mains and wastes. Consequently the solder would be more likely to find its way through if the socket, which should be about a quarter of an inch deep, were left open, as advised in the case of pipes subject to pressure. Having a good hot pot of solder, splash on until the whole of the solder is raised to a good heat ; then have a large iron at a dull red heat, and start wiping at one end of the joint. Keep the solder well warmed by the frequent application of the iron, and wipe off at the same end as the start was made. Do not use a thin cloth if a good-shaped joint is required. The dimensions of the cloth should be about three and a half inches by three, and six or seven thicknesses of moleskin cloth.

# CHAPTER XXVIII.

## LARGE UNDERHAND JOINTS.

ALTHOUGH the subject of wiped joints has been treated pretty fully and comprehensively in the foregoing chapters, yet it cannot be said that the matter is anything like exhausted. There are so many ways and means adopted by different plumbers in various localities for the purpose of accomplishing a similar result, that one might fill volumes, if so disposed, in describing the variety of methods, the fads and fancies, prejudices and eccentricities relating to joint-wiping and the men who wipe them. But it will not be advisable to dwell too long even upon such a popular subject as joint-wiping is acknowledged to be by all engaged in the trade. We must, therefore, pass on without unnecessary delay to consider other joints of equal interest. There is one part of the subject of joint-wiping that has not been dealt with, namely, large underhand round joints on soil and other large pipes, and, although this class of joints is to be considered last, they are by no means the least in importance. They are in fact found to be, in the experience of most plumbers, the most difficult joints to make, especially to those who have had but very little experience in joint-wiping. On this account every possible means are generally used, by what may be termed second-rate plumbers, to avoid their use. On the other hand, there are many plumbers who prefer to make an underhand joint to an upright one, more particularly where it can be fixed near the floor or on

a bench, or some other equally convenient place; the fixings for wiping are generally much more simple and firmer than for those fixed upright. Of course, these remarks apply principally to work being prepared in the shop, but when the pipe is in its proper position the joints have to be made according to the circumstances of the case. For instance, soil pipe joints have to be wiped when the pipe is fixed in a slanting direction as shown at Fig. 165. This, of all positions, is the most difficult to wipe a joint in. It can neither be treated as an upright nor an underhand joint conveniently, although a good joint-wiper has very little difficulty in making them in a similar manner to that adopted in ordinary underhand joint-wiping.

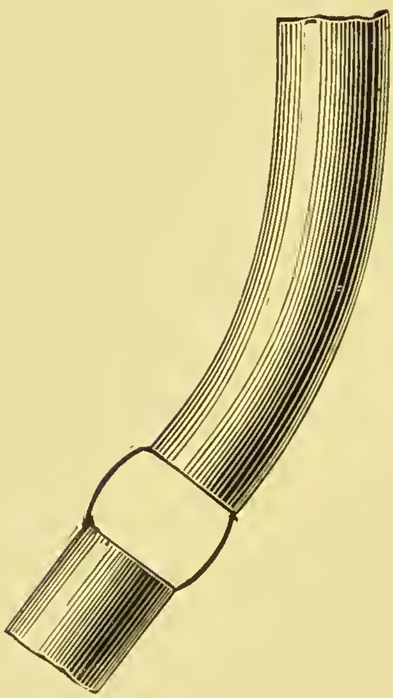

Fig. 165.

Now while it is absolutely certain that the art of joint-wiping can only be properly acquired by continual practice in the workshop, especially is this the case with regard to large underhand joints, yet a few additional hints will perhaps be useful to many who find these joints very difficult to make in such a manner as to bear the test of measurement with the calipers. There are many plumbers who suppose that a large underhand joint cannot possibly be made as smooth and as regular as one made upright. They take it as a matter of course that a four-inch underhand joint must necessarily be rough or lumpy underneath, and that it

cannot be made without a large amount of tin running to the bottom, making it irregular and unsightly. There are other plumbers who would on no account attempt to make a large underhand joint with the same kind of solder as that used for upright joints. They think it necessary to reduce the fineness of the solder by adding some lead to it. By this means they spoil the quality of the solder for the purpose of suiting their unskilfulness in the use of it.

In my opinion, the most severe test in plumbing examinations is the large underhand joint-wiping. There are large numbers of plumbers who are fairly good lead-workers and joint-wipers as far as small pipes are concerned, and they can make a very good upright joint on a soil pipe, but as soon as they are put to large underhand joints they seem quite out of their element, and after five or six heats they leave a joint that is not fit to be seen. Fig. 166 is a sketch of a joint of this kind; the only satisfactory part about them is that they are sometimes sound.

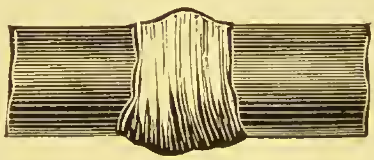

Fig. 166.

One of the principal reasons why these joints are not made properly is that a sufficient heat is not generally raised before the joint is wiped, or if there should be enough heat it is not equally distributed round the whole of the joint.

After preparing the joint as already described with regard to upright joints, the next important thing is a good wiping cloth. As a rule, cloths for large underhand joints are too small both in size and thickness. For a four-inch joint the cloth should be six inches by five and about ten thicknesses of moleskin cloth, or fustian as it is sometimes called. Tick is not at all a suitable material for large cloths, for as soon as it becomes warm it is so limp as to be quite useless for making a good-shaped joint. As some plumbers

find it difficult to hold a large cloth while they are wiping, it is a very good plan to have a strap fastened to the back, so that the hand may be slipped through it as shown at Fig. 167. Where joints have to be wiped in awkward places the cloth being fastened to the hand is a great help, although in ordinary cases a good joint-wiper would rather prefer a cloth without the strap arrangement.

Having obtained a good cloth, the next thing is to get up a good heat; but to do this easily it is not necessary that the solder should be too hot, a moderate temperature is much more suitable for these kinds of joints. If the solder is very hot only a very thin stream can be poured on with safety. But a thin stream is not sufficient for large underhand joints; what is wanted is a stream of solder that will run down each side of the joint to the bottom, there to run off on to the cloth. At frequent intervals this solder should be brought to the top of the joint, where the hot solder should be again poured on until nearly the whole of it runs to the bottom and again falls into the cloth. It will readily be seen that if the solder is very hot this continual flow and movement from the top to the bottom and so on, cannot be effected so quickly and easily, because to get the large flow with such hot solder would very quickly cause it to burn a hole in the top of the pipe, especially if it is done by one not used to such joints. After the first ladle of solder has been carefully poured on, it is not necessary to pour on the bare tinning at all, because as soon as the top is bare the solder should be drawn up from the bottom at once, to protect the bare pipe from the solder as it falls from the ladle. If this rule was observed when making underhand

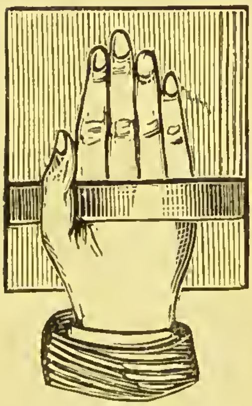

FIG. 167.

joints of any size, there would be but little danger of burning holes in the pipe and making solid joints.

When the solder, all round the joint, has been raised to a uniform heat and consistency, take the cloth in the right hand, if preferred, and start at the back by roughly forming the shape, and drawing the surplus solder to the top and over the front, at the same time cleaning the edges. Now take the cloth in the left hand and push the surplus solder under the joint and up towards the back where the start was made. During this movement the edges require most attention, therefore be sure all surplus is removed from them before proceeding further. Now with the cloth in either hand and the fingers bending the cloth to the required shape of the joint, quickly draw the surplus over the top again, then with a sharp wipe remove the solder that is not required; another wipe underneath and over the top should complete the joint, which, if done quickly and skilfully, should be as clean and true as it would be if wiped upright. One of the most important points to observe when wiping joints of this kind is, after the pouring on is done, to continually keep the cloth wiping one way round and round the joint, not to pull the solder up one side and then up the other as many do. This is the very reason why the tin runs so much to the bottom, where it sets and becomes immovable. But when the surplus solder is wiped right round the joint in one direction, it has

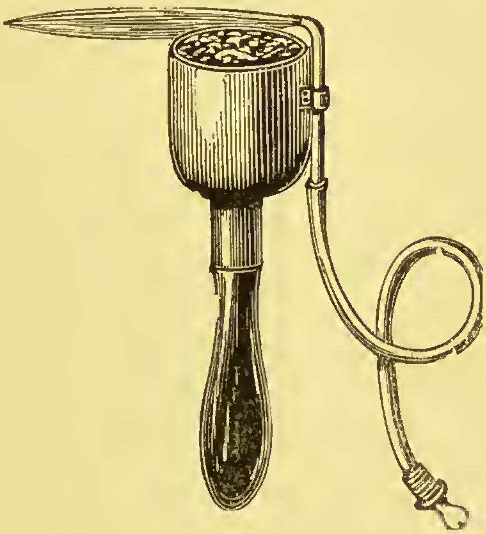

Fig. 168.

the effect of keeping the whole at a comparatively uniform heat ; at the same time the solder is kept in a proper condition until the joint is finished. It may be observed that the plumbing iron has not been mentioned in connection with large underhand joints. Not that I should advise any one not to use it when they are making joints of this kind, that is, if they prefer to use one. But the arguments in favour of the use of irons to branch or upright joints are not exactly applicable in the case of underhand joints, nor are the conditions of the two kinds of joints identical.

Now one of my principal arguments in favour of the use of irons is that the continual application of heat to the

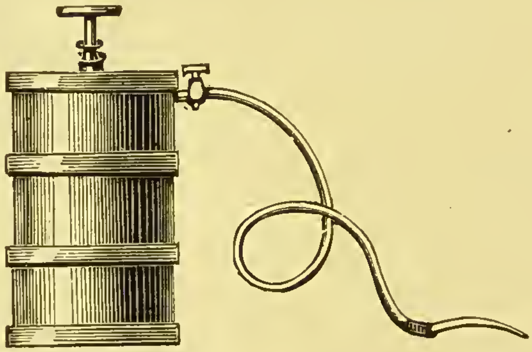

FIG. 169.

solder while an upright joint is being made, assists in keeping the solder in its most favourable condition, that is, the tin and lead of which it is composed are kept equally distributed throughout the mass. But in the absence of irons or their equivalent, the tin percolates through the particles of the lead to the lower part of the joint, or more correctly it runs below the joint, the most important part of which is really at the centre of the solder. In the process of wiping the upright joint, this lower part of the solder, which is generally surcharged with tin, is not brought again to the top, especially if the joint is wiped without an iron, but in the case of the underhand joint, if it is wiped in the

way above described, the richer solder does not really run away from the joint, as is the case with the upright joint, but only percolates from the upper part to the lower, but not wholly remaining there, because as the wiping proceeds it is brought again to the top, and indeed distributed over the whole surface of the joint; this action is, of course, repeated until the solder sets. It is, therefore, in my opinion, not at all necessary to use an iron to a large underhand joint, providing it is wiped in such a manner as to keep the solder as much as possible from becoming in a state of disintegration. As a matter of fact, a large underhand joint,

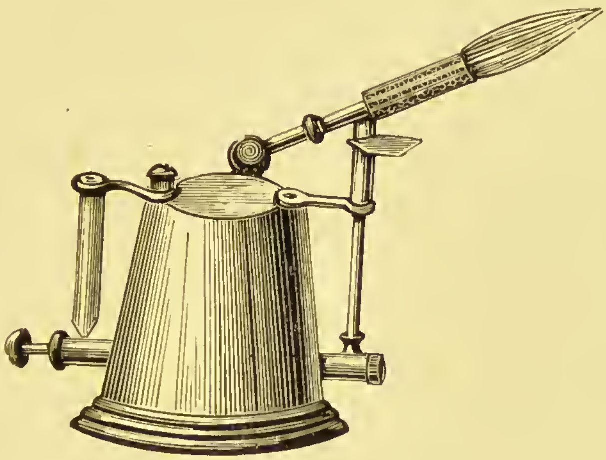

FIG. 170.

under ordinary circumstances, is much more easily wiped without an iron than with one; it can be done more quickly and with less effort, and as quickness is really the secret of efficient joint-wiping, in this case the iron is perhaps a disadvantage. There are, of course, many instances where large underhand joints cannot be made so easily; there are awkward positions where ordinary means are not sufficient, therefore irons or other things have to be employed to assist the plumber in making even a sound and reliable joint; as to the appearance, that is often out of the question. It is in such cases that the spirit lamp or blow-pipe flame is found

to be very convenient. Fig. 168 is a sketch of a very handy and simple blow-lamp. It consists of a metal cup filled with cotton waste, which is saturated with benzoline; air is blown across the flame through a small tube fixed to the side of the cup. A rubber tube is attached to the air jet, having at the other end a wooden or earthenware mouthpiece. Fig. 169 shows another apparatus that is being very largely used for soldering; this is also charged with benzoline, air is blown through by means of an air pump, the air mixing with the vapour from the spirit passes through a flexible tube to a jet, and produces a powerful flame, which can be used for many kinds of soldering. Fig. 170 is a sketch of what is called an automatic torch, which I understand works on a similar principle to the last-mentioned apparatus, inasmuch as air is blown through benzoline by an automatic arrangement. Not having used one, however, I cannot say more about it, but hear that it is a very useful machine.

In several instances in my own experience, large horizontal joints have had to be treated much in the same manner as a branch joint, inasmuch as it has been impossible to use a large underhand cloth to wipe them owing to the awkward position in which they have been placed. In such cases a flame of some kind has been very useful in assisting the use of a small cloth.

# CHAPTER XXIX.

## SOLDERS.

THE composition and properties of solders are a matter of considerable interest to plumbers, and, indeed, to all metal workers; but the subject is of especial importance to plumbers, because on the quality and purity of solder depend in a large measure the reliability, good appearance, and general quality of their work. Nothing is more annoying, nor is there anything so productive of bad work, waste of time, and consequent irritability and bad temper, as the condition of a plumber who is attempting to do good work with bad material, particularly if that material is wiping solder, or, as it is generally called, "plumbers' solder". Until recent years it was almost invariably the practice for plumbers to make their own solders, either from the pure lead and tin, or, as was generally the case, old joints and solderings, commonly called "hards," were melted down, and tin added in proportion to the quality of the "hards" used for the purpose. But of late years it is becoming quite unusual for journeymen plumbers to know anything about solder-making. Master plumbers consider it more economical to buy it, already made, of their lead merchants, to whom it is supplied by firms who make solder-making a branch of their manufacturing trade. Another advantage to both masters and men is, that if supplied by a firm of good reputation, it can generally be depended upon for purity and uniform quality.

When solder is made with "hards" or old materials of

any kind, such as old sheet lead and pipe cuttings, it is often difficult to eliminate all the impurities that are sometimes present, especially when such things are used in large quantities. Good plumbers' solder should consist of two parts of lead to one of tin, but the proportions, of course, vary according to the quality of the constituent parts. Tin, for instance, varies very much in quality, and no fluxing or a superabundance of the tin will make good solder if this metal is of an inferior kind. It is, therefore, far the most economical in the long run to use tin of the very best quality.

Now, as the exact proportions, as they are generally given, depend to a very great extent upon the condition of the two metals, it follows that the mere mixing of certain quantities of tin and lead does not necessarily make a composition that will serve the purpose that it is intended for. There are, no doubt, large quantities of this kind of solder made and used, but a plumber with an experienced eye can detect at a glance the inferiority and, one might almost say, the uselessness of such solders when required for the execution of good work.

Although it is not absolutely necessary that a good solder-maker should be a plumber, it is important that he should have a considerable knowledge of the appearance of solder in proper condition. This knowledge can be best gained by communication with plumbers who have to use the solder, especially if it is possible to get a plumber to try it on a joint before it is run into the moulds, in the form shown at Fig. 171. In large plumbing shops this plan is very often adopted; but in the absence of a practical test, there are certain indications by which the solder may be judged, whether it is good or bad. The most common practice is to run out a strip of solder on a smooth level stone. As soon as the strip is nearly cold, the quality of

the solder or the proper proportion of tin and lead can be determined by the appearance of both surfaces. It is important, before running the solder out on the stone, that it should be at such a heat as to allow the solder to run freely. A temperature just below red heat is the most suitable for this purpose; otherwise, if the solder is not hot enough, it will have a dull white look, whether it is good or bad.

If it is in good condition, it should have a clean, silvery appearance; bright spots should also form on the surface from an eighth to a quarter of an inch in diameter. As a rule, the larger the spots the finer is the solder, although some kinds of tin will not show large spots, however much is used. In such cases they should appear more numerous.

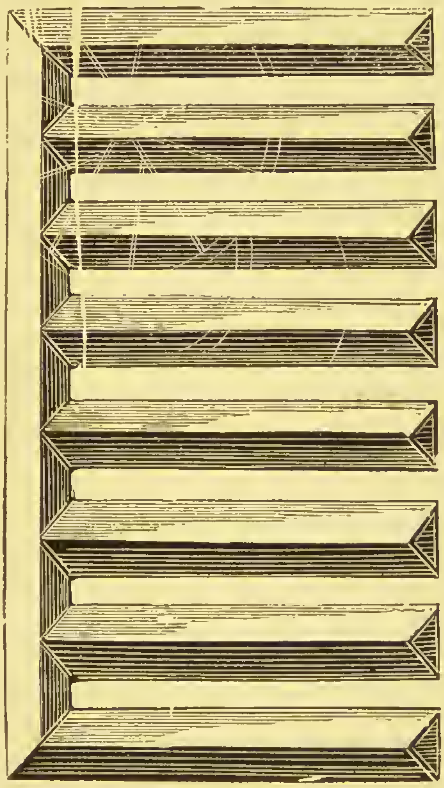

Fig. 171.

If the strips have a dull, dirty appearance and a kind of a mottled surface, it is evident the solder is not so pure as it should be. It probably contains some mineral impurities, which can generally be removed by well heating the solder in the pot, and stirring into it a quantity of resin and tallow. These substances have but very little, if any, chemical effects, either upon the solder or the foreign matters it may contain; but the action that seems to take place is that they combine with the lighter

mineral matters by what may be called adhesive attraction, and cause them to rise to the surface, where they can be skimmed off. There are some earthy impurities that get into the solder, the specific gravities of which are probably much lighter than the solder itself, but which will not rise to the surface until assisted by means of fluxes. It may seem strange that such should be the case; but it must be remembered that although tin has a specific gravity of 7·3 and lead 11·445, and it is, therefore, necessary to well stir the solder while it is being poured into the moulds, as the tin will continually rise to the top, yet if it were not stirred at all after it was once mixed, the lower portion would not be wholly deprived of tin, showing that the greater specific gravity of the one does not wholly displace the other. The same is evidently true of certain impurities, which are not removed until they are washed out, as it were, by means of fluxes, such as resin and tallow.

The greatest enemy to plumbers' solder is zinc. If the slightest trace of this metal gets into a pot of solder, it is almost a matter of impossibility to wipe joints with it, especially underhand joints.

When zinc is present, the strip of solder has a dull, crystallised appearance on the surface. The tin spots are also very dull and rough, and not at all bright and clean. When solder of this kind is being used for wiping, the first thing noticed is that a thick, dirty dross forms on the surface directly after it is skimmed. It is impossible to keep the surface clean for even a second. When it is poured on a joint, it sets almost instantly, and it matters not at what heat it is used. As soon as one attempts to move it with the cloth, it breaks to pieces, and falls off the joint.

In the case of branch joints when an iron is used, the solder cools in hard lumps, and breaks away like portions of wet sand. There are two or three ways of extracting zinc

from solder; one is to partly fuse it, and when it is nearly set to pulverise it until the particles are separated as much as possible. The whole is then placed in a pot or earthenware vessel and saturated with hydrochloric acid, commonly called "spirits of salts". The acid dissolves the zinc and produces chloride of zinc; the latter can be washed out with clean water and the solder returned to the pot in a comparatively pure state. This method cannot be recommended as a certain cure, because of the difficulty there exists in dividing the particles to such an extent as to expose the whole of the zinc that may be contained in it, and considering the small amount of zinc that is sufficient to poison a pot of solder it is doubtful if the acid process is radical enough in its action to thoroughly eradicate the zinc without repeated applications.

In my opinion sulphur is the best thing to use for this purpose. On several occasions in my own experience the following method has been adopted with complete success:—

When a pot of solder has been found to be poisoned with zinc, it has been heated to just below a red heat (it is of no use stating a fixed temperature in cases of this kind, because a thermometer would never be used in practice for this purpose). Rock sulphur, generally called brimstone, is broken up and granulated; it is then screwed up tight in three or four thicknesses of paper, and in this form is thrown into the pot and held below the solder with a ladle. As the paper burns the sulphur rises through the solder, combines with the zinc, and floats on the surface. The solder is well stirred so as to thoroughly mix the sulphur with the whole of the contents of the pot; the dross which is formed by this process is then skimmed off with a ladle and thrown away as useless.

Now in the case of the sulphur, although it is generally called a flux, the action that takes place is altogether different to that of resin and tallow. A thoroughly scientific explanation of this action by a competent authority would be very

interesting, but in the absence of this it may safely be inferred by reference to the results of chemical combinations that the zinc, having a great affinity for sulphur, as soon as it comes in contact, forms sulphide of zinc; this is really a substance similar to zinc blende, a common form of zinc ore. In this condition, the specific gravity being considerably reduced, it readily rises to the surface of the solder, where it can be skimmed off with a ladle.

The question naturally arises—why is it the sulphur does not combine with the lead to which it also has an affinity, and thus form sulphide of lead? If lead is heated only just above its melting point and then some sulphur is mixed with it, a substance would be formed similar to galena, or sulphide of lead. But if the temperature is raised several degrees higher the sulphide gives up the lead, and either floats to the top or passes off in the form of gaseous vapour, chemically termed sulphurous anhydride. Therefore, by heating the solder containing zinc to a temperature just below redness, it is hot enough to prevent the sulphur combining with the lead and tin, but not sufficiently heated to cause the sulphur to give up the zinc, which fuses at a higher temperature, 773°, whereas lead fuses at 612°, and in combination with tin as solder at 441°. The difference in the melting points is in all probability the principal cause of the sulphur attracting the zinc and leaving the lead and tin comparatively unaffected.

Another method of extracting the zinc from solder is to raise the temperature to a very bright red heat; if this is continued long enough the zinc vaporises and passes off in a gaseous state.

The latter is a very wasteful process because it cannot be done without a large proportion of the tin becoming decomposed by oxidation. The oxide gathers in the form of a powder on the surface, and is what is commonly known as putty powder. One of the most common means of

spoiling solder is that last mentioned. Solder heated to redness in a current of air very quickly loses some of its tin and becomes poor.

One of the best kinds of stoves for heating solder is shown at Fig. 172. This is made of cast iron. Where a good draught can be obtained they heat the solder and irons very quickly. They are also more economical than large open fireplaces, and the solder is kept in a purer state. There is one improvement that might be made in these stoves; there should be more room for fire directly under the pot. At present the pot has to depend to a great extent on the flame passing under it; if the grating was extended further under the pot a larger body of fire could be placed where it is most wanted.

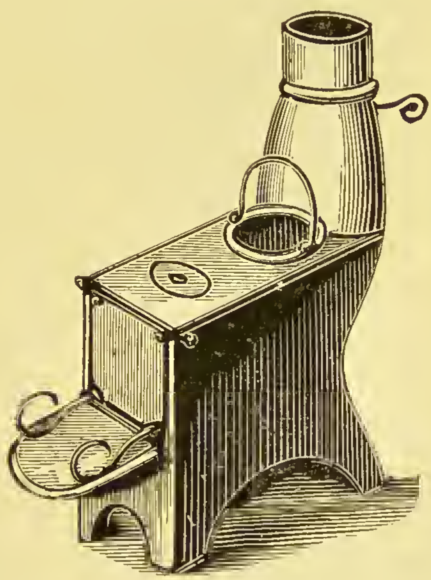

FIG. 172.

Fig. 173 shows another kind of fire pot which is very good for outside work; it is better and not so wasteful as the old-fashioned open devils, as they are generally called. They are made of wrought iron, and have a cast or wrought iron grate in the bottom. With either wood, coal, or coke a large pot of solder can be heated in a very short time. For roof work they are very useful, but they should always be set in a lead safe or tray containing water, so as to quench the cinders as they fall through the grating or out of the holes in the sides, where the irons are heated. There is considerable difference of opinion amongst plumbers concerning the best kind of fuel to use for fires on which the

solder, or, as they are more often termed, "metal pots," are heated. Certainly coke is the most economical, especially on large jobs where large fires are necessary. Some have an idea that coke fires poison the solder with the sulphurous fumes that are given off, but this idea must be principally imaginary. In my experience the solder works just as well when heated over a coke fire as it does over any other.

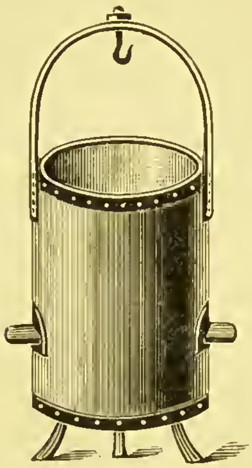

Fig. 173.

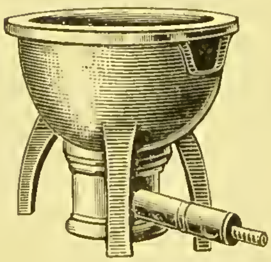

Fig. 173 a.

In fact, in ordinary cases, it is impossible for the fumes to come in contact with the solder to any great extent, or at any rate of sufficient volume to make any appreciable difference in the quality of the solder.

The way the damage is done to solder when heated with coke, is by upsetting part of the solder and letting it run through the fire and then putting it into the pot again. The result of this is, the solder works coarse and sandy, and is full of dirt. The cause is principally owing to that already mentioned; in passing through the fire the tin is oxidised, or what is commonly called "burned". The rest of the metal takes up certain sulphurous and other impurities from the coke, and hence becomes unfit for use: whole pots of solder have been spoiled in this way. Care should be taken, then, not to return the bad metal to the pot, but to keep it separate until it has been cleaned with plenty of resin, and replenished with more tin.

Where a gas supply is available the gas pot shown at Fig. 173 A answers admirably for melting solder.

One of the most remarkable things about solders, or indeed any combinations of metals forming alloys, is that a much lower degree of temperature is necessary to fuse them than would be the case if the metals forming the alloy were melted separately. It is, of course, owing to the low melting points that the usefulness of solders is mainly due.

This mixture of metals can be so arranged as to make the melting point of the alloy less than half the degrees of heat that would be required to melt one of the metals alone, and that one may be the easiest to melt of those of which the alloy is composed. Tin for instance melts at 442°, bismuth at 500°, and lead at 612°, yet if these three are mixed in the following proportions, 3 of tin, 5 of bismuth, and 2 of lead, the melting point will be about the boiling point of water, which is 212°; this it will be seen is considerably less than half the heat required to fuse tin.

It is said of Sir Isaac Newton that he composed a fusible metal, or alloy, consisting of 8 parts of bismuth, 5 of tin, and 3 of lead, which, though hard enough to polish when it was cold, would melt so readily in hot water that spoons made of it would disappear in stirring a cup of tea, to the no small dismay of an ignorant person. Although this may, no doubt, seem incredible to many persons, it is by no means the lowest temperature by which an alloy, or more correctly, an amalgam, can be melted, for with the addition of 3 parts of mercury to 5 of tin, 3 of bismuth, and 3 of lead, it will enable the alloy to be fused at such a low degree as 122°. There are, of course, many different proportions of the metals already mentioned that can be arranged to fuse at almost any temperature between 200° and 440°, that is with-

out the aid of mercury, as this is never used for solders, but only for certain medical or surgical purposes. Plumbers, as a rule, have very little use for the softest kinds of solders; they are principally concerned with the two kinds which are generally called the coarse or wiping solder, and fine or copper-bit solder: the former, consisting of 2 parts of lead and 1 of tin, melts at about 400°; the latter has the proportions reversed, namely, 2 of tin and 1 of lead—this melts at 346°. The lowest temperature at which it has been found that an alloy of lead and tin will melt is 334°, but, strange to say, with a less proportion of tin than in the last-mentioned alloy—3 of tin and 2 of lead are the proportions necessary for the lowest melting point of the two metals.

Therefore it does not follow that the more tin a solder contains the finer it is, or rather that it is more suitable for soldering. The solders that fuse at the lowest temperature are generally most suitable for soldering joints on soft metals such as tin, or when alloys are used like pewter, Britannia metal, and others containing bismuth and antimony, which consequently melt at a low temperature, and require a delicate blowpipe flame for applying the heat for soldering joints or seams.

It is, however, found in practice that it is not so well to have the solder that is used in lead work, and applied with the copper-bit, too fine. It is, of course, all very well for tinning, or for soldering brass or copper, but when it is required for soldering seams on the side of a trap or bend, for instance, as is very often the case, it should be in such a condition as to flow after the bit has left it, and cool perfectly smooth and bright. If there is an excess of tin in the solder this well-floated seam is impossible; it is almost as bad as an excess of lead. The result is generally a very rough seam, the solder having cooled in patches instead of a continuous smooth surface without a break or wave.

It may be well to state at this point, that the flowing of solder, especially that used with the copper-bit, depends to a large extent upon the fluxes that are used for tinning purposes. For soldering lead only a very simple flux is necessary, namely, a little tallow and powdered resin. The same kind of flux is also very often used for tinning and soldering brass and copper, and there are many plumbers who use nothing else but a piece of composite candle, which seems to answer the purpose very well. For soldering iron, zinc, and tin goods, chloride of zinc, or what is commonly called killed spirit of salt, is generally used, although it is not necessary to kill the hydrochloric acid or "spirit" when zinc has to be soldered. Of late years, however, soldering fluids and preparations have been invented which have, to a very large extent, superseded the common fluxes. The disadvantage of spirit of salt is owing to the tendency it has to produce oxidation on iron, and chlorides on zinc, after the soldering is done. But if a flux like "Baker's preparation" is used, it not only does not produce rust, but it prevents corrosion; it also makes the solder flow much better, and the soldering is much cleaner. In addition to this, no noxious vapours are given off as is the case with hydrochloric acid.

It would be interesting to try and find out the reason why a combination of metals fuses at such a low temperature when compared with the fusing points of the component parts of the alloys. In the first place, it is necessary to bear in mind the fact that all metals, and indeed all matter, is composed of minute particles or molecules, and that there are nothing existing that is a strictly solid uniform mass. It is also acknowledged that the molecules of different substances always assume a distinctive shape, and when metallic matter is crystallised, as it is said to do when it becomes solid by the action of cold, these particles are

attracted to each other by a force of more or less power according to the nature of the metal, whether it is said to be hard or soft.

Now the force by which these aggregations of minute particles are held together is what is called "cohesive attraction," and the power of this force to hold the particles together depends to a very great extent upon the particular shape which these extremely small particles assume, and the amount of surface which they present to each other. It is very easy to conceive that if a number of bodies have a mutual attraction for each other, the larger the surface that comes in contact the more force is there exerted one with the other. If, for instance, the particles take the form of spheres like a number of marbles, the surface in actual contact is comparatively very small indeed; the same would be the case if they were very irregular in form. But if each particle took the form of a cube, or some other regular body, the attraction would be greatly increased, as each of the particles approached and fitted into its proper place. It is not contended that the molecules are actually attracted into absolutely close contact, because, as a matter of fact, they are not. In every substance, however hard and solid it might appear to be, there are certain interstices between the particles which are called pores, the capacities of which vary according to peculiar conformation of the particles, and the degree of affinity which one set of particles may have for others in the same mass. It follows then that as a rule the hardness or softness of any substance depends, according to the theory of "cohesive attraction," upon the close and compact nature of the molecules, and the large or small spaces or interstices between them, that is, so far as the action of heat is concerned. If it is required to make a hard substance soft and pliable, some power is necessary to exert a reactionary influence upon the attrac-

tive force which causes the particles to cohere. Now the only power that will effectually produce this result is heat; when heat is applied to nearly all metallic substances, the first thing it does is to enlarge the bulk by the almost irresistible force of expansion.

It has already been stated in a previous chapter that heat is scientifically termed "molecular motion". The effect that heat has on a solid is to cause the particles to be thrown further apart from each other by a repulsive force, overcoming to a certain extent the force of cohesive attraction. This repulsive action continues to increase as the temperature is raised, until the attractive force has to give way to the force of gravity.

The result is the particles will no longer cohere in a mass, but fall away from each other and become in a state of fluid, and if they are not kept together in a vessel of some kind during their high temperature they will run in any direction by the influence of gravity like ordinary liquids. When a metal is in such a condition it is said to be melted or fused. There are some metals, zinc for instance, the particles of which are separated to a much greater extent than is the case with fusion only. For if the heat is applied so that the temperature is raised above fusing point, evaporation takes place, and the molecules are driven off in the form of vapour. This subject of the *effects of heat* is so extensive and profound, that one can only indicate a few points in the vast fields of scientific research that bear more particularly on the matters we are most interested with. But perhaps enough has been stated in the foregoing remarks to show the principles under which the alloys of different proportions of metals are made to fuse at such low degrees of temperature.

The principal reason appears to be that when two distinct metals are mixed together, such as tin and lead,

the cohesive attraction is modified to a large extent, because the molecules of one have a comparatively small affinity for the other. Of course tin has a certain amount of affinity for lead; in fact, if there were no affinity between the two, solders would be useless on lead, because tinning could not be effected if such was the case. But what seems certain is, when the two metals are alloyed, the molecules are not held together by the same attractive force that is exerted when a metal is not alloyed. We may therefore infer that the particles of one metal do not, by reason of their difference of construction or conformation, have the same affinity for each other as they do when they are not intermixed with other particles of a different nature.

Consequently, when such combinations of metals are subjected to the action of heat, the particles mutually assist each other to separate, and gravitate like liquids to a level surface, with a much lower degree of temperature than is required to obtain the same effect when the metals are melted separately.

Then with regard to wiping solder, it retains its fluid and plastic state for a much longer time than lead or tin would before they are mixed, showing that the particles, probably for the same reason, do not solidify so quickly as they would in a separate state. If they did, joint-wiping would, of course, be impossible, for on the peculiar power that solder has to retain its heat, or rather the effects of heat, depends the success of the most important parts of plumbing work. It is very difficult to comprehend many of the characteristics of metallic alloys, with regard to their expansibility—for instance, an alloy of lead and tin contracts considerably in cooling; the result of this can be seen when a solder pot is placed on the fire. Before the bulk of the solder melts, but as soon as that part which is near the hottest part of the fire begins to fuse, the molten metal forces its way up

to the top, between the sides of the mass of solder and the sides of the pot; this often continues until the top of the unmelted mass is covered with a melted layer which has forced its way there, showing that when the solder cooled it contracted into a smaller space than it occupied when it was in a fluid state. Consequently, when the lower part of the solder is melted first, the expansion that takes place forces it of necessity to the top, because there is not room for the increased bulk in the space it was reduced to during the process of cooling. But if *antimony,* the fusing point of which is 840°, is added to lead and tin, the result is just the reverse, for on cooling this alloy expands. The latter alloy is generally used for casting types for printing, the proportions of which are two of lead, one of antimony, and one of tin, although a more expansive alloy is made of nine of lead, two of antimony, and one of bismuth. Then with regard to the hardness of metals, it is not always that the hardest metals require the highest temperature to fuse them. Tin, for instance, is much harder than lead, yet it fuses at a temperature nearly 200° lower than lead. There are many other peculiarities about metals which would be very difficult, and indeed impossible, to explain, even if this were the time or place to further enlarge upon so vast a subject. But as we have only remarked upon that which mostly interests plumbers, it would be best for my readers who desire to know more of the subject, to read some of the many works that have been written on this important branch of science. In fact, there have been throughout these chapters on "Hints to Plumbers" many subjects which have only been treated as the title implies, merely as "hints" or suggestions, for the purpose of encouraging further investigations at any rate in a scientific direction.

## CHAPTER XXX.

### AUTOGENOUS SOLDERING OR LEAD BURNING.

ALTHOUGH the art of lead burning has for many years been kept quite distinct from plumbing generally, it is nevertheless essentially a branch of the trade, and one in which large numbers of plumbers are becoming very proficient. Not that there is required a large amount of skill or ingenuity in the execution of lead burning, because, as a matter of fact, when it is compared with first-class plumbing, it is not nearly so difficult to acquire. In my own experience men who have been failures as plumbers have been able to do lead burning very well, but, on the other hand, a professed lead burner is, as a rule, as far removed from a competent plumber as he would be from any other trade. For the old style of lead burners were not necessarily plumbers, for they concerned themselves but little with the working and manipulation of lead, at any rate from a plumber's point of view ; for in most cases where lead burning was considered necessary, such for instance as lining large chambers in chemical factories especially for the manufacture of sulphuric acid, the lead was simply used in large sheets fixed with tacks to wooden framework and the edges burned together. Of late years, however, this method of burning the edges of lead together has been adopted for numerous other purposes, such as the lining of sinks for chemical laboratories, and lining cisterns in cases where the water attacks the solder, besides the joining of stamped and bossed lead forming ornamental features on roofs, etc. In

France it is used for the latter purpose much more than it is in this country, for a large amount of the ornamental work there is stamped in moulds and joined together by the burning or a similar process. In the last Paris Exhibition there were some very fine specimens of lead statuary which were evidently constructed in this manner. In one instance, which attracted the attention of a party of plumbers, there was a nearly life-size statue of the Madonna made of lead. At first sight one would think it had been bossed out of two or three pieces of lead. But finding that it contained no wooden mould, and that a large hole was left between the shoulders of the figure, one of the party was curious enough to get up and peep inside.

It was then discovered that the whole of the statue had been constructed of pieces of sheet lead of irregular shape about six inches across and the joints burned or soldered together inside and the outside cleaned off. For excepting a seam which could be detected down the back no other join was visible, although those inside were left without the least attempt to clean them off.

The modern term for lead burning is "autogenous soldering," but this is applied especially to the method which is carried out by the airo-hydrogen blow-pipe. The word "autogenous" is rather an ugly one, and somewhat difficult to define; it pertains to the word "autogeneal," which means "self-begotten or generating itself," neither of which is very appropriate to the process of lead burning. In fact the latter term is not strictly applicable, because the lead is not burnt, it is only fused. The most suitable term would be "fusing process". Instead of saying "the seams are burned," it would be better to say "the seams are fused," as this would correctly describe the action that takes place. There seems to be an idea prevalent that this method of joining lead is comparatively modern, but this is only in the

case of the hydrogen flame, which is said to have been invented by a Frenchman in 1838. The actual process of joining lead pipes by fusion, however, is very ancient, because there is no doubt that the leaden water pipes used by the Romans were joined together in this way. But instead of using a flame it was done by molten lead being poured on the parts to be joined, as briefly described at Fig. 59. This was of course a very rough way of doing it, and not to be compared to the modern style of burning. Among the several means used of joining lead by fusion none are more effectual than the hydrogen flame, or, as it is more correctly termed, the airo-hydrogen flame, as a certain quantity of air is mixed with the hydrogen to produce a small flame of intense heat; although there are other means, such as coal gas and air, or a pure oxygen flame which can be adopted much more conveniently and with less danger to the operator. The airo-hydrogen flame is produced in the following manner. An apparatus is constructed similar to that shown at Fig. 174. It may be made in different ways, but the pipes and chambers must be formed of lead without solder, or if solder is used it must not come in contact with the acid.

It is therefore necessary to burn all the joints and seams of the machine before the hydrogen can be produced on the spot for autogenous soldering. The machine consists principally of two chambers A and B. The upper one is open at the top, but the other is hermetically sealed for the purpose of retaining the hydrogen gas under pressure which is produced by the column of dilute acid in the pipe G. The first operation is to place some pieces of zinc in the lower chamber B, resting them on the leaden grating H. The access opening at C through which the zinc is introduced can be closed by a circular leaden plate, and held to the flange by clips and thumb screws, or bolts and nuts, and

made gas-tight by a washer of cork, cardboard, or asbestos, although a layer of grease would answer the purpose.

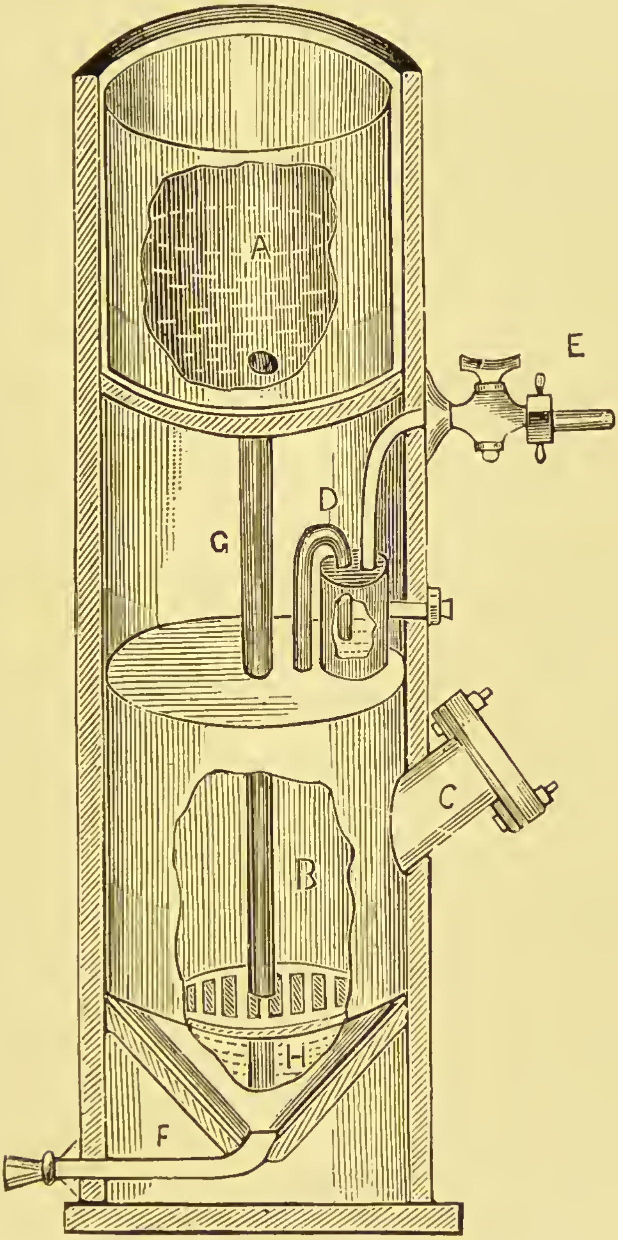


FIG. 174.

A sufficient quantity of water is then poured into the upper chamber until it is about one-third full. To this

should be added about one-fourth or one-seventh its bulk of sulphuric acid. The proportion varies according to the quality of acid, but the right quantity is soon found in practice.

While the machine is being charged the tap E should be shut off and pipe F plugged by a good cork or a wooden plug. A cock would of course be more convenient, but as most of them are made of brass the acid in this case would soon make it useless.

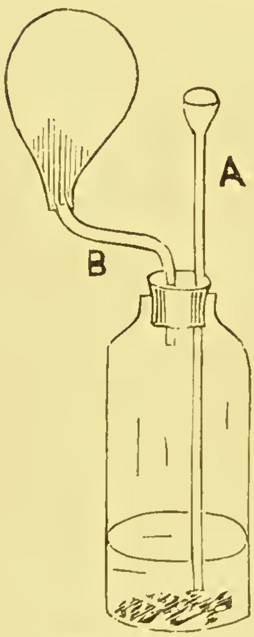

Fig. 175.

Now as the bottom chamber is made air-tight it will be readily seen that when the liquor which has run down the pipe G has risen in the bottom chamber B to the end of the pipe, it can rise no higher until the air is allowed to escape. Then as the liquor rises in the pipe G and begins to fill the upper chamber, the air in the lower chamber becomes compressed to a degree equivalent to the height of the column of liquor. In the first instance therefore the dilute acid does not reach the zinc, but as soon as the cock E is opened the air escapes and allows the liquor to submerge the zinc. When the dilute acid comes in contact with the zinc a chemical action is set up, the result of which is that the dilute acid becomes decomposed by the hydrogen being driven off in the form of gas and the metal attacked converted into zinc sulphate, which is dissolved in the water.

As soon as the gas is formed and begins to accumulate further pressure, it should be made use of, or otherwise it will force the water down in the generating chamber, and up the pipe G from whence it will escape.

A very simple experiment can be performed for the purpose of making hydrogen gas on a small scale, by means of a wide-mouthed bottle and two glass tubes as shown at Fig. 175. One tube should have a funnel-shaped mouth as shown and be long enough to reach nearly to the bottom of the bottle, the other should only just pass through the cork in which both should be made air-tight. After placing a few pieces of scrap zinc in the bottle a small quantity of dilute acid (about 7 of water and 1 of sulphuric acid) should be poured down the funnel tube. Hydrogen will then be seen to generate and rise in bubbles through the acid to the surface. As hydrogen is very light, being the lightest of all gases, it can be stored for a few minutes in a flask and be held upside down over the tube B in the sketch. The hydrogen being the lightest, it will rise and displace the air in the flask.

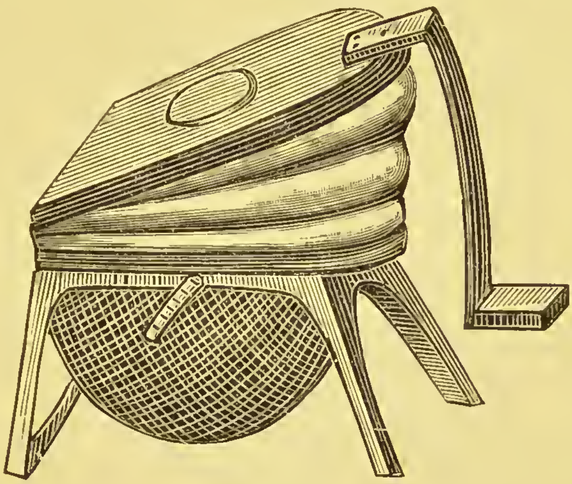

FIG. 176.

A similar chemical action is produced by the familiar process of making chloride of zinc, or, as plumbers generally call it, killed spirits. When the hydrochloric acid is poured on a piece of zinc a sharp effervescence will take place. If a light is applied a series of minute explosions occur and a blue flame is seen. This is caused by the combustion of the hydrogen. The difference in the residue is that sulphuric acid leaves sulphate of zinc and hydrochloric acid chloride of zinc.

But to return to our hydrogen machine, it must be remembered that all vessels which contain an inflammable

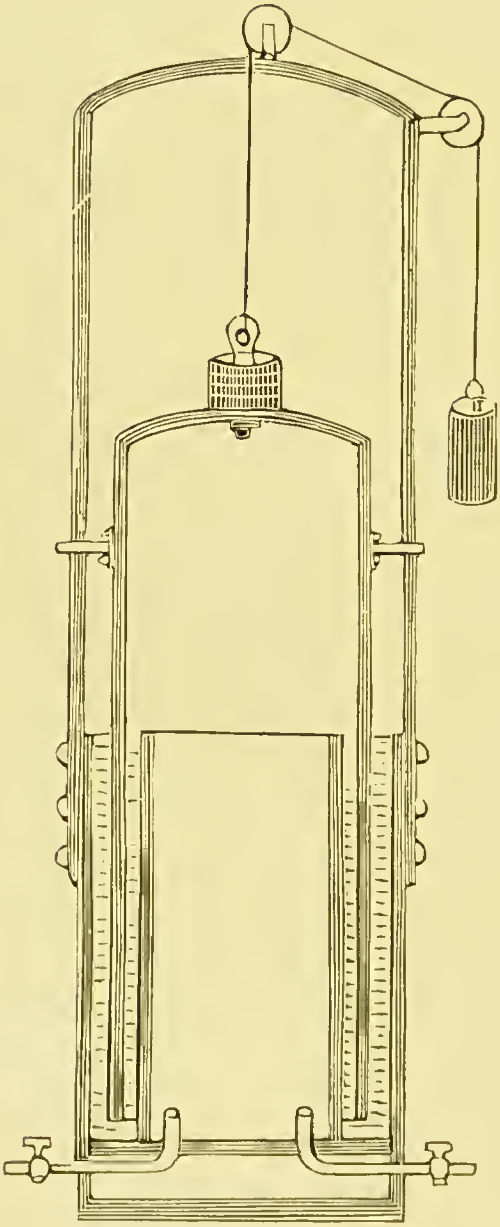

FIG. 177.

gas must be guarded against the possibility of a return of a mixture of gas and air, and especially when they are likely

to bring the flame back with them. It is therefore advisable to pass the gas through a chamber formed as shown at D, Fig. 174. This contains water into which the outlet pipe from the chamber B dips. In the event of a return of gas this effectually checks its passage into the generating chamber.

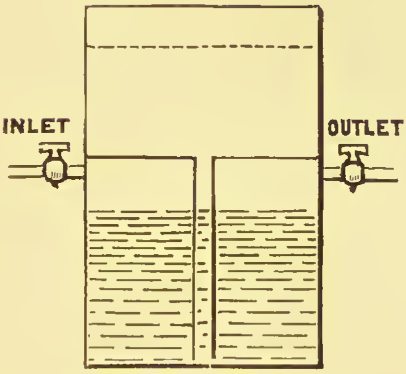


FIG. 177 A.

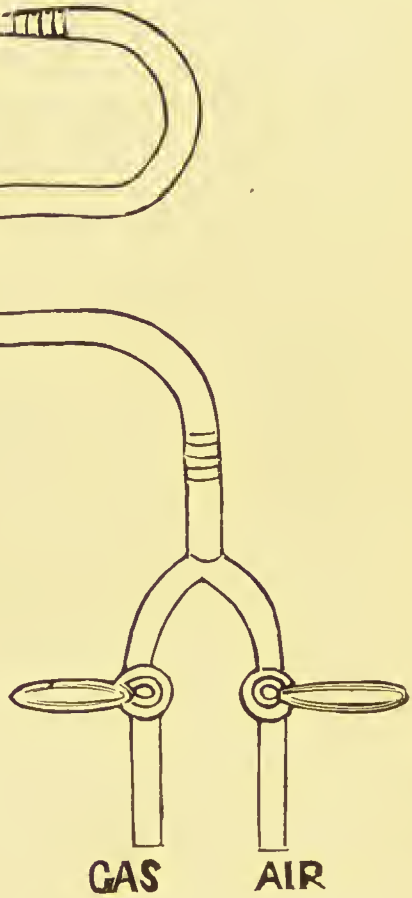


FIG. 178.

When the acid is exhausted it is drained out by the pipe F, which is also used to convey the water used for washing out the machine. The rest of the apparatus is very simple, it consists principally of a bellows of some kind for the purpose of producing a blast. That shown at Fig. 176 answers the purpose very well, and by the aid of the

india-rubber wind chamber at the bottom will give a tolerably steady blast. But it cannot be denied that some means of storing the air and delivering it under a steady pressure is a great advantage. This can be accomplished by using an apparatus similar to that shown at Fig. 177. It is made on the principle of a gas holder, the upper bell-shaped chamber dips in water and rises and falls in accordance with the amount of air it contains.

The pressure is regulated by the amount of weight placed on the top of the air chamber. Or if the rise and fall movement is regulated by a pulley-wheel, cord and counter-balance, the pressure can be adjusted by the balance weight. By such an arrangement the air can be forced into the air chamber by an ordinary bellows, and delivered to the blow-pipe at a steady even pressure. The blow-pipe, jet and regulating cocks are shown at Fig. 178. Various sized jets are used to suit different kinds of work, which only practical experience can determine.

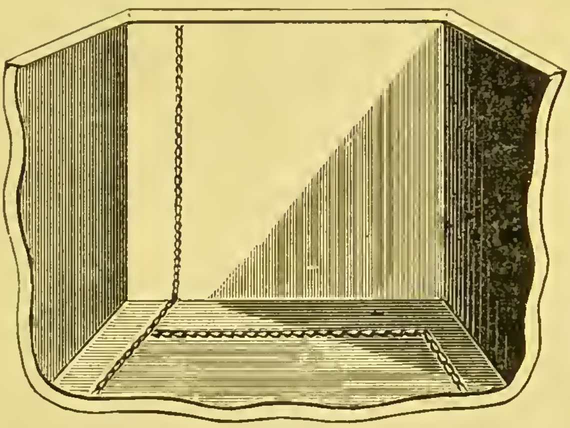

Fig. 179.

The simplest kind of lead burning is that known as flat seams, and which as a rule is the only kind that plumbers are likely to be wanted to make use of. Professional lead burners of course are required to burn seams in many different ways, even horizontal seams overhead are sometimes necessary. When the seams of sinks and cisterns have to be burned, the joins should always be arranged about 6 inches from the angles much in the same way

as a zinc worker would line the same vessel with zinc, as in Fig. 179. Because if the seams are arranged in the angles the flame of the blow-pipe is likely to catch the surface of the lead at the side and burn them through before the seam is formed. It is best also to butt the edges of the lead and not to lap them. Then when each edge has been shaved about a quarter of an inch wide, take a strip of shaved lead about half an inch wide and direct the flame on the end until a drop is melted and falls on the seam ; at the same time the flame should be directed towards the part of the seam to be burned, for the purpose of heating it. Then cause the flame to play upon the small drop of lead until that and the lead upon which it rests are fused, then draw up the flame quickly. This operation, owing to the intense heat of the airo-hydrogen flame, occupies much less time than it takes to describe it. So that the operator has to be quick in manipulating the blast if he wishes to avoid burning the lead over a much larger space than is desirable. It must not be supposed that a flowing seam like that produced by a copper-bit and fine solder can be formed by the burning process ; this, under the circumstances, is not possible. Fig. 180 shows the appearance of a burned seam. Each wave has to be formed separately by a distinct application of the flame. The regularity of these waves will depend partly upon the skill of the operator, partly upon the

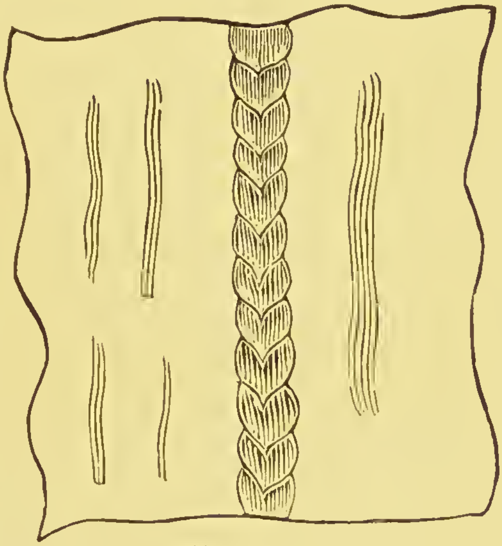

Fig. 180.

quality of the blast and on the purity of the lead upon which it is being used. But like most other mechanical operations proficiency has to be attained by practice and experience. When it is found necessary to burn seams on the vertical side of a cistern, the lap is generally arranged in a slanting direction, as shown at Fig. 181 A, for the purpose of forming

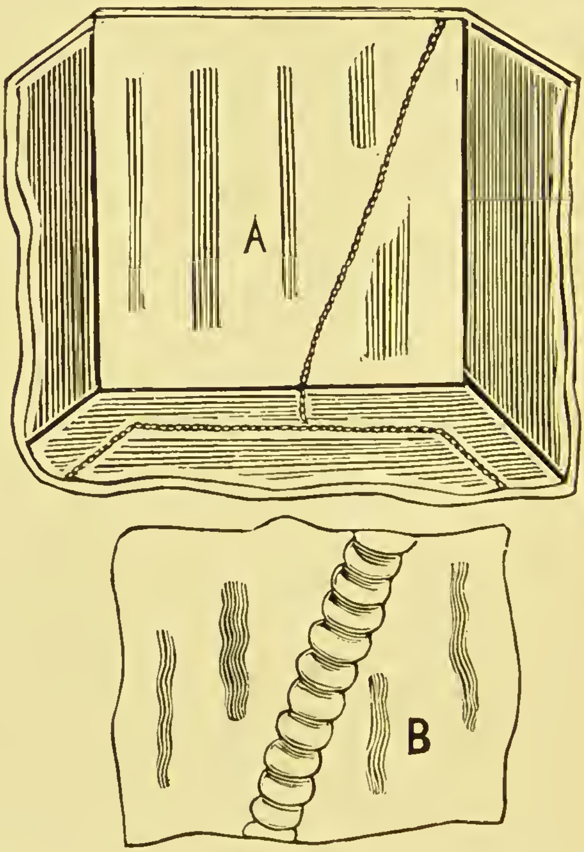


FIG. 181.

a ledge for the drops of molten lead to rest upon until they are fused into the seam, which, as will be seen in the sketch at B, is formed of a series of drops, instead of waves. A similar appearance is obtained when seams are burned on an upright side of a cistern in a horizontal line. This is shown at Fig. 182, and of the three forms of burning is

undoubtedly the most difficult to do satisfactorily. Now, having briefly described the "lead burning" or "autogenous soldering" machine, it may possibly prove more interesting if some more convenient methods for obtaining similar results were alluded to. In the first place, for ordinary lead burning, such, for instance, as plumbers generally are required to execute, the pure hydrogen gas is not absolutely necessary. For by the use of a good bellows such as that shown at Fig. 176 and a properly arranged blow-pipe similar to that shown at Fig. 183 carbonetted hydrogen or ordinary coal gas and air can be used for the purpose. In fact, in my own experience a very large amount of lead burning has been done by this means. It is not, of course, pretended that the flame is so intense, nor is it so well adapted for lead burning on a large scale, but for a great variety of purposes it is very convenient and effectual. It is difficult, by this method, to get the waves so regular as the hydrogen flame enables them to be formed, although, if the blast is well regulated, after considerable practice the hydrogen burned flat seam can be closely imitated. The last-mentioned blow-pipe is similar to that shown at Fig. 138, but constructed in a better form and calculated to give better results. It can be obtained of a well-known manufacturer of gas blow-pipes.

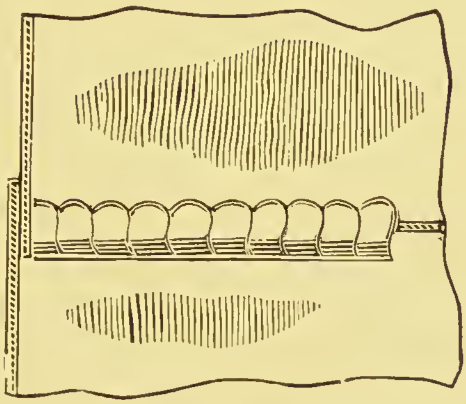

FIG. 182.

Another very convenient way to produce a good flame for lead burning is to use compressed oxygen and coal gas. The oxygen can be obtained in steel bottles; this, being discharged under great pressure, is used for the blast instead

of air; a bellows is therefore unnecessary. The blow-pipe, Fig. 184, is similar in outward form to Fig. 183, but internally the tubes are differently arranged.

When it is stated that a small sized blow-pipe of this kind with a supply of oxygen at the rate of 7 cubic feet per hour, and a gas supply through a quarter-inch pipe, will fuse a

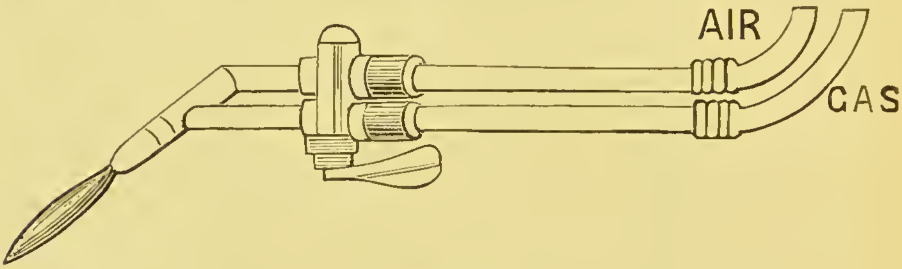


FIG. 183.

quarter-inch wrought iron rod easily, the intense heat of the flame can be somewhat realised. Probably the oxygen method of burning would be rather costly where only small jobs of lead burning are occasionally required, but where there is a considerable amount to do the compressed oxygen would be far more preferable to the cumbersome and often troublesome hydrogen machine.

FIG. 184.

There is yet another method which has been adopted to a very large extent for lead burning, namely, the use of red-hot hatchet copper-bit.

There is one plumbing firm within my knowledge that does a large amount of lead burning for its particular style of work and that uses no other means. The seam is placed —in the case of a pipe—on an iron mandrel, or if a flat

seam on an iron plate, and the hot copper-bit is drawn through, slowly fusing the lead together as it goes. A core or bed of sand will also answer the purpose.

It is, of course, a rough and ready way of doing it, and it involves a large amount of time and labour in cleaning off the seams. But it is nevertheless effectual, and, where more skilful means are not at hand, it often serves the purpose in a rough way. It would not, however, do for general application; in fact, in numerous instances where lead burning is required, it would not be at all practicable.

In conclusion, it may be well to point out that the idea of substituting the burning system for soldering generally in plumbers' work is not at all likely to be an accomplished fact. It is all very well for special purposes, but the art of soldering in the modern style is too well established to be ever superseded by the comparatively inartistic methods of lead fusing. Not only is lead burning not so attractive or so substantial in appearance as soldering, but it is not nearly so well adapted to general plumbers' work, and there does not at present seem any probability of it ever becoming a successful competitor.

Recently another air-pressure chamber has been introduced as shown at Fig. 177 A. A bellows is used for forcing the air in, this causes the water to be raised up the centre tube to the upper part of the chamber, thus keeping the air in the lower chamber at a pressure equal to the head of water in the tube. It acts similarly to Fig. 177, but it is a simpler arrangement.

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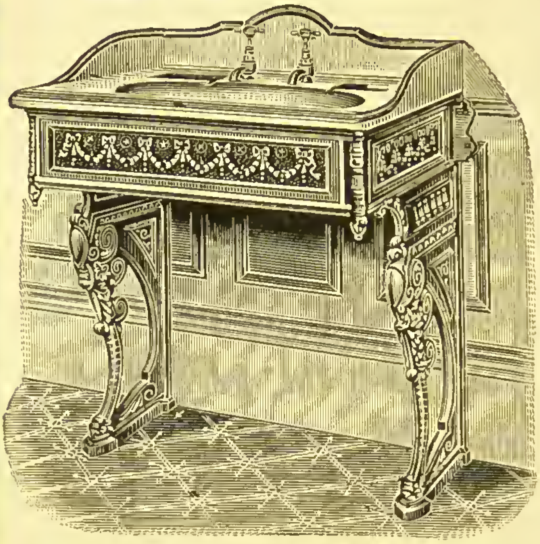

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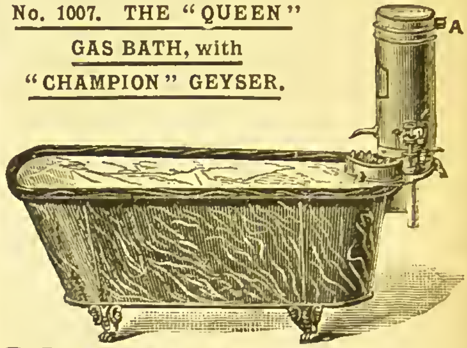

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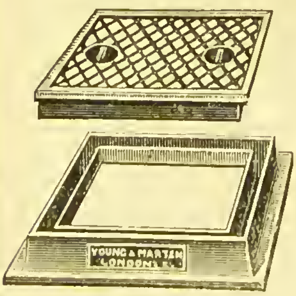

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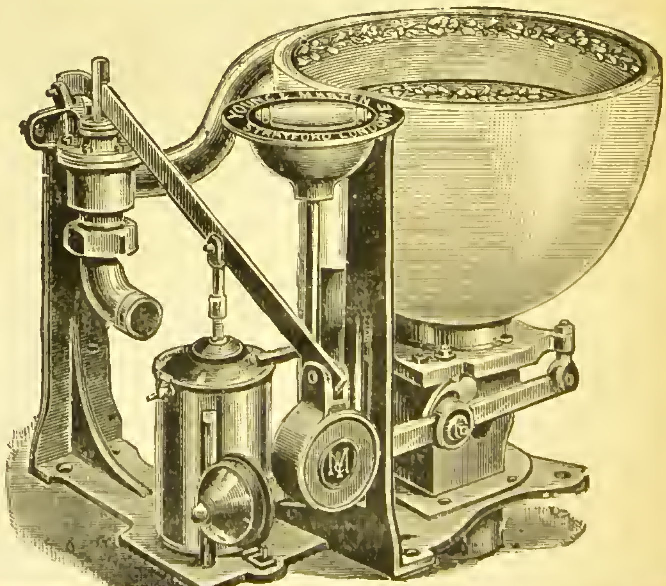

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